THE WORST TECH PRODUCTS OF THE CENTURY

apc

SINCE 1980

20 TECH FLOPS

CHIP WARS

Where Intel went wrong & how it's fighting back

YOUR EXPERT GUIDE TO TODAY'S TECH
SEPTEMBER 2020 #484

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WORK MACHINES

17 PORTABLE POWERHOUSES RATED HEAD-TO-HEAD

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Commodore 64

How to run C64 games on your PC today

REVIEWED

AMD Ryzen XT CPUs

Is a little more enough?

REPAIR YOUR WINDOWS INSTALL

Fix issues and speed things up again

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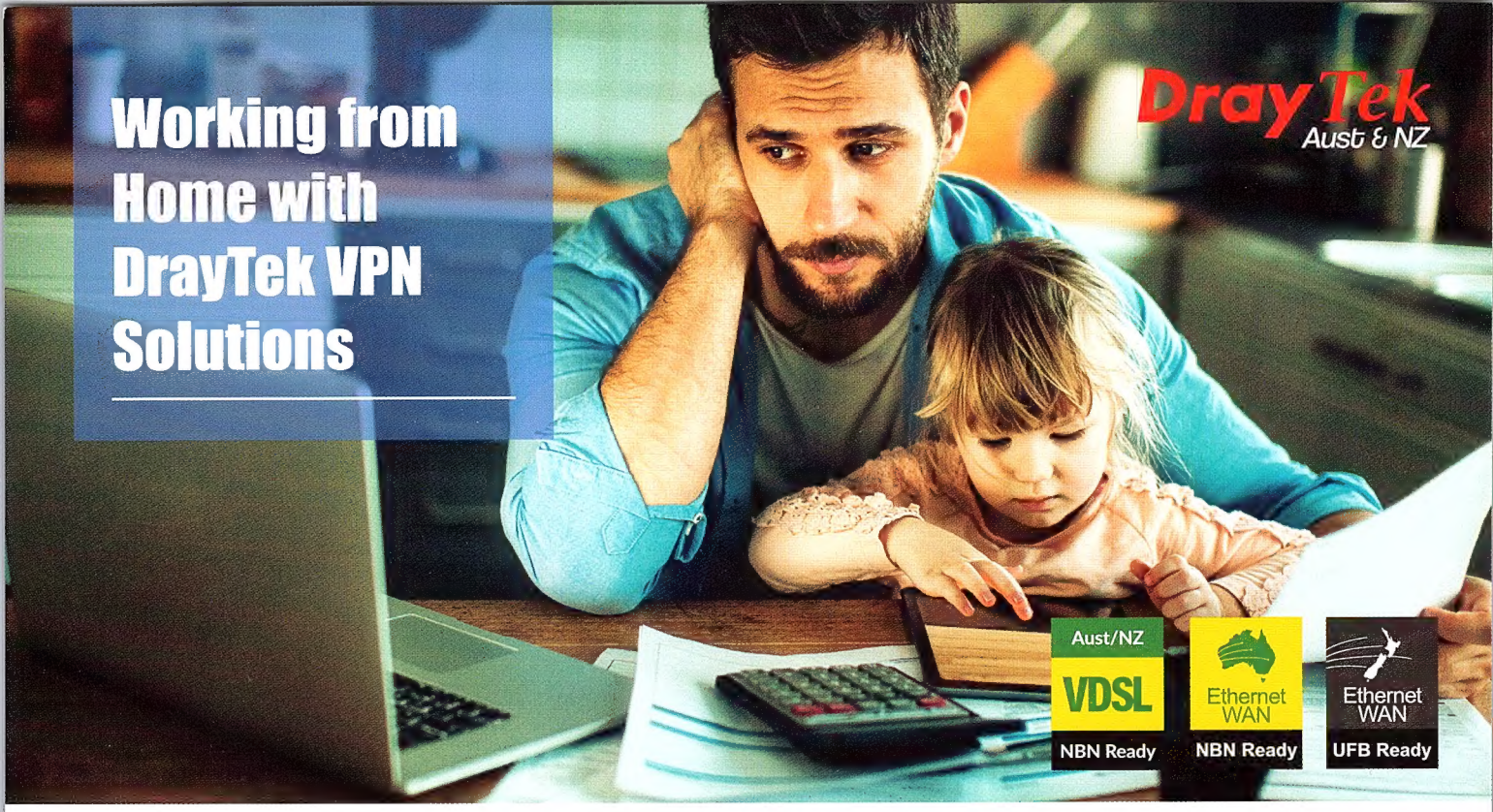

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VigorAP 912C (Wi-Fi Mesh AP)

802.11ac Wave 2 Access Point with Mesh Wi-Fi, 1 x Gigabit PoE PD port and ceiling mount housing

Vigor2926 Series

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Vigor2133 Series

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VigorAP 802 (Wi-Fi Mesh AP)

802.11ac Wave 2 Access Point/Range Extender with Mesh Wi-Fi and wall plug housing

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EDITORIAL

WELCOME TO ANOTHER FINE MONTH OF COMPUTING

EDITORIAL

Picking winners

And, losers.

One of our feature stories this month is a fun look back at some of the more notable tech flops. I'm sure you have had many sour experiences with tech that looked great, made promises, then just plain disappointed. After reading through Christian's article a couple more came to mind.

The first, and biggest I think – especially now with so many of us working from home – is lamenting what could have been with the NBN. Just imagine if we were living with a fibre to the premises NBN. Sending large amounts of data up and down the line generally *functions* with an average 50Mbps NBN connection and its 20-30Mbps upload, but it could have been so much better.

Speaking of WFH tech fails – just as the COVID emergency was gaining momentum and lockdowns were ordered, and the video conferencing thing exploded overnight – pity poor Asus, which launched its ROG Zephyrus G14 laptop right at the time. To save some money, excused by a claim that not everyone needs this – it does not have a webcam. It's not the only one, either. You can bet that little attempt at a new trend will disappear basically forever.

And, an obligatory word on *Star Citizen*, of course. It's now been almost seven years since I sunk over $1,000 into buying a fleet of jpegs. I had high hopes of enjoying the space-faring life within a couple of years of that late-night internet shopping splurge, and my fleet was carefully selected to do it all. Here we are in 2020 and yes indeed the beta persistent universe is getting bigger every year, but it's still beta, and usually all progress is lost when there's a new update. It's years from completion and feature creep went into out of control territory several years ago, with too much emphasis (IMHO) on making it an FPS.

And all the rest. The trick is to know what'll fail when it first appears, which isn't always easy... let us hope that the products we've recommended in this issue last the distance!

BEN MANSILL

"An obligatory word on Star Citizen, of course. It's now been almost seven years since I sunk well over $1,000 into buying a fleet of jpegs."

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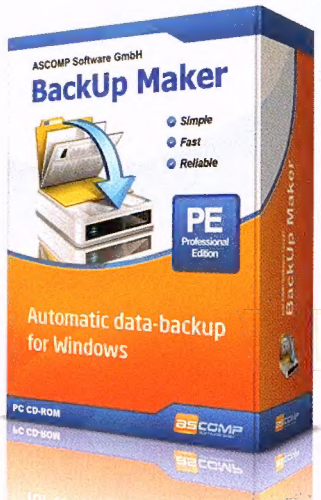

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| Up to NVIDIA® GeForce® RTX 2080 SUPER™ with Max-Q Design |
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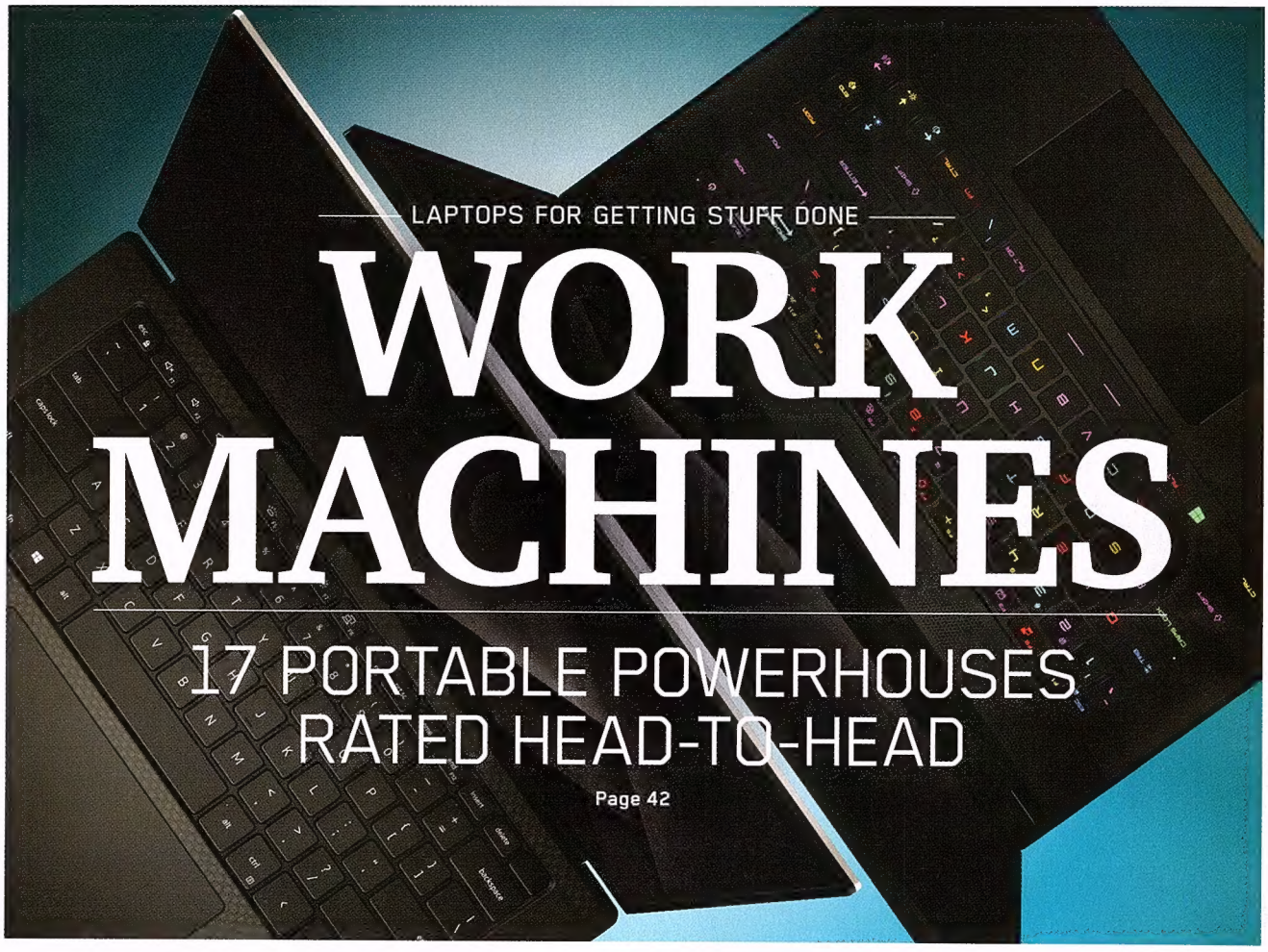

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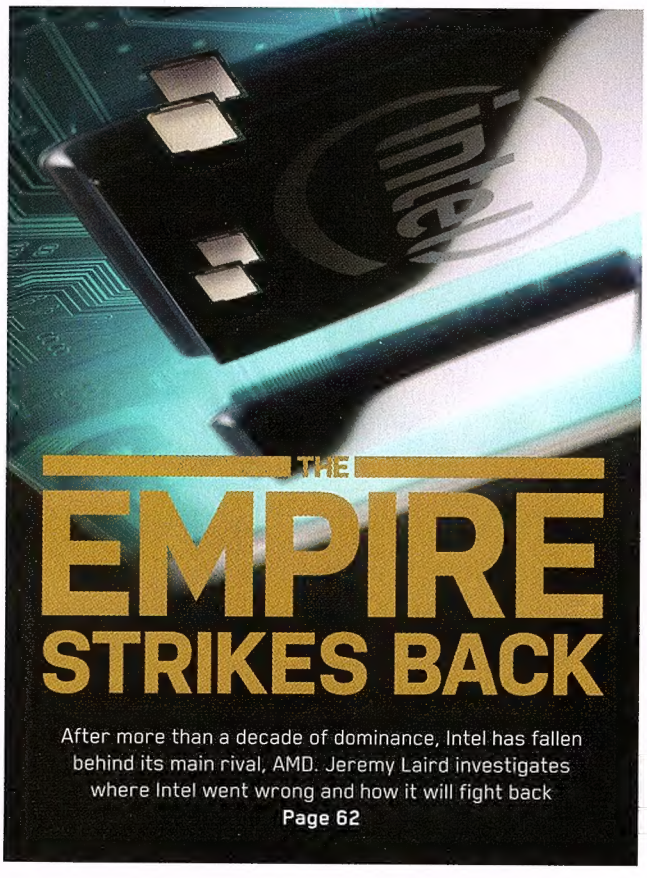

THE EMPIRE STRIKES BACK

After more than a decade of dominance, Intel has fallen behind its main rival, AMD. Jeremy Laird investigates where Intel went wrong and how it will fight back

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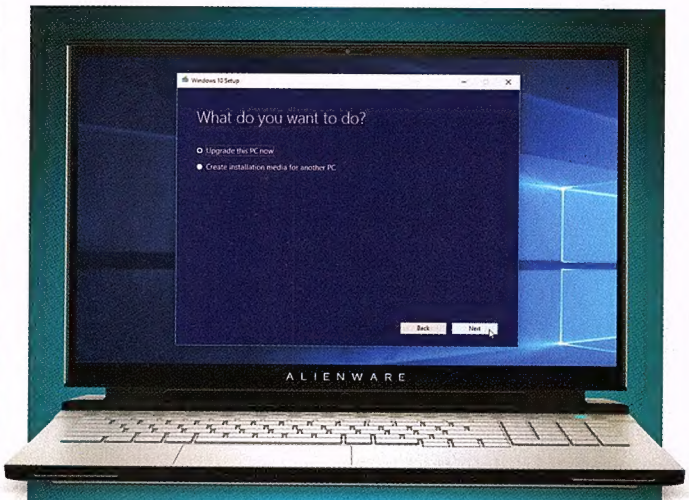

Repair a Windows install

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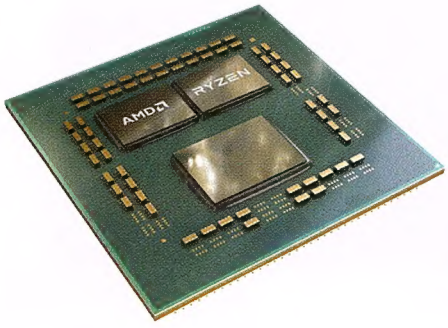

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REVIEWS
THE HOTTEST GEAR LABS TESTED
AMD Ryzen 9 3900XT, Ryzen 7 3800XT and Ryzen 5 3600XT
Ryzen XT underwhelms with small gains and a big price tag.
"AMD says you can expect about a two percent improvement with the 3900XT and a four to five percent improvement with the 3800XT, depending on the title. We didn't see as much uplift, though."
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APC HOT PRODUCT
When a reviewed product scores 4.5 out of 5 or higher, it carries the Hot Award. These are products that exceed expectations and deliver a quality experience up there with the very best.
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APC RECOMMENDS
You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

Inside *APC*

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

"APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible."

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

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ROG Sheath Electro Punk Mousepad

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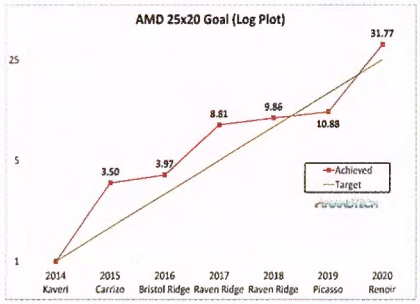
TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS



Pic: Anandtech

AMD succeeds in its 25x20 goal

RENOIR CROSSES THE LINE IN 2020.

In 2014 AMD committed to itself, to customers, and to investors that it would achieve an overall 25x improvement in 'Performance Efficiency' by 2020, which is a function of raw performance and power consumption. AMD has now confirmed the company has reached its goal, which started from the Kaveri baseline.

A big leap came with Raven Ridge, with AMD combining its new highly efficient Zen x86 cores and Vega integrated graphics. From 2017-2019 there was a lull in AMD's strategy, namely because there were no significant design changes. The jump from Picasso to Renoir is 2.92x, taking AMD to 31.77x – over the original target. Goal achieved, and kudos to AMD's teams that have succeeded at this ambitious target.

Nvidia allegedly kills off four Turing graphics cards

TURING MIGHT BE PREPARING ITS EXIT IN ANTICIPATION OF AMPERE.

Chinese publication *IThome* has reported that Nvidia is ostensibly discontinuing the GeForce RTX 2070, RTX 2070 Super, RTX 2080 Super, and RTX 2080 Ti. We've reached out to Nvidia, but the chipmaker has told us that it doesn't comment on rumours or speculation.

It makes sense to start phasing out Turing-powered models to dedicate resources for the new and upcoming Ampere graphics cards. If Nvidia continues to use the same development cycle for Ampere, the chipmaker will already have working samples of Ampere. And if things progress as they are, mass production would likely commence in August. If the information is accurate, the chipmaker could announce the GeForce RTX 3080 and RTX 3080 Ti in September, which is the rumoured month for Ampere's launch.

Pic: Shutterstock

CPUS

SoftBank considering selling Arm

Focusing on an initial public offering.

SoftBank is considering fully or partially selling British chip designer Arm Holdings and has hired Goldman Sachs to advise it on further Arm deals, according to a report from the *Wall Street Journal*.

This comes as a bit of a surprise after Apple's promise to swap to the Arm-based Apple Silicon within two years, though this isn't the first time SoftBank has indicated potentially returning Arm to the public market. The Japanese company currently owns Arm in its entirety, after buying the company for US$32 billion in 2016.

Arm designs the microprocessors that power most of the world's smartphones. Apple, Samsung and Qualcomm all make use of Arm technology, though any attempt on Apple or Samsung's part to buy Arm outright would likely trigger intense regulatory scrutiny. Further, even with Apple Silicon, few companies have a need to own Arm outright, given the breadth of its business. A return to the public market is probably more likely, with sources telling CNBC that "the announcement was made to focus the company on an initial public offering more than a year from now."

CONNECTED

Intel announces Thunderbolt 4 specification

One USB-C cable to rule them all.

With speeds up to 40Gb/s, Thunderbolt 4 maintains the same maximum speed rating as its predecessor and doesn't enable new features, however, the new specification requires vendors to enable all of the optional features built into Thunderbolt 3, like the ability to hit the 40Gb/s data throughput requirements and support two 4K displays or one 8K display, in order to qualify for Thunderbolt 4 certification. The specification also requires support for PC charging on at least one computer port (for devices under 100W).

Thunderbolt 4 also calls for universal cables (up to 2 meters in length) that support 40Gb/s of throughput, addressing the current confusing array of different types of USB-C cables and ports into one central solution that has a simplified branding scheme (a single lighting bolt logo). Thunderbolt 4 cabling will come in 0.2m, 0.8m, and 2m lengths, with plans for 5 to 50m cabling in the future.

BILLION

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Dual SIM

802.11n

IPv6 Support

Firewall

VPN Security

BIPAC 8920NZ

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CAT.6

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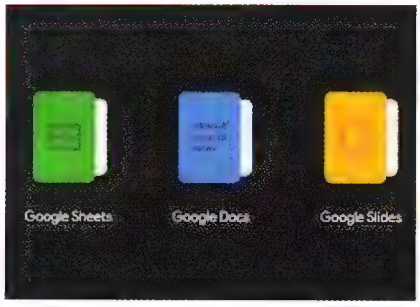


Dark mode lands for Google Docs, Sheets, and Slides on Android

LOOKING GOOD, WITH PRACTICAL BENEFITS.

The wave of software and apps that are getting the 'dark mode' treatment continues, ceaselessly beating against the default, glaring white of their interfaces. Google has now announced that its G Suite products – Docs, Sheets, and Slides – are all getting support for Android's system-wide dark theme, as well as their own independent modes. The company claims that this tweak "can make it more usable in low-light environments and save battery life".

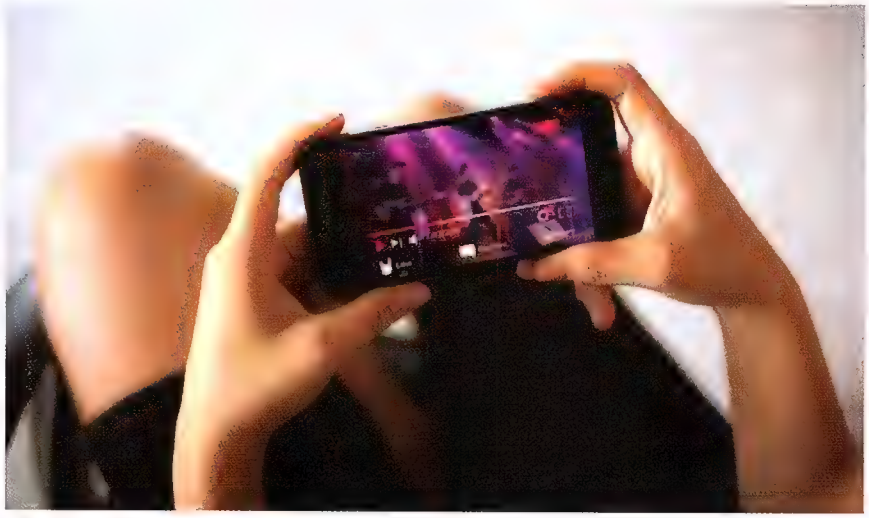
Enabling it is simple – Android users just need to activate the system-wide dark theme (found in their device's settings), or alternatively navigate to Menu > Settings > Theme > Dark from within either the Docs, Sheets, or Slides apps to activate them independently.

MSI CEO Charles Chiang dies suddenly at 56

THE CIRCUMSTANCES ARE STILL UNDER INVESTIGATION.

A leading hardware company has lost its leader. On July 7th in Taiwan, MSI general manager and CEO Charles Chiang passed away after falling from one of the company's buildings. Chiang, 56, had been with MSI for more than two decades before taking over as chief executive in 2019.

"Earlier today, MSI GM and CEO Charles Chiang passed away," an MSI spokesperson announced. "Having been a part of the company for more than 20 years, he made outstanding contributions and was admired by his colleagues. Mr. Chiang was a respected leader in the MSI family, and helped pave the way for the brand's success. We are all deeply saddened by the news, and are mourning the loss of Mr. Chiang. He will be deeply missed by the entire team."



Pic: Shutterstock

ALGORITHMS

H.266 VCC video codec promises to cut file sizes in half

What comes after HEVC.

Fraunhofer HHI (Heinrich Hertz Institute) has announced the new H.266 codec, also known as the Versatile Video Coding (VVC) codec. The H.266 standard is the result of three years of work from Fraunhofer HHI and its partners.

With an enhanced compression algorithm, the H.266 codec promises to maintain the visual quality of the current H.265 codec, also known as High Efficiency Video Coding (HEVC), but at an about 50% smaller file size. That would make H.266 perfect for efficiently transporting high-resolution content, such as 4K or 8K media, through mobile networks. Furthermore, the H.266 codec also supports HDR content and 360-degree videos.

To put this in perspective, a 90-minute 4K video consumes up to 10GB of space with the current H.265 codec. According to Fraunhofer HHI's figures, the same video with an identical level of quality would only require 5GB of space with H.266. The transition from H.265 to H.266 could indeed be a quantum jump if the latter can deliver on its promise. In its press release, Fraunhofer HHI said that the CPUs required for H.266, especially the mobile chips, are still in development.

GENERATIONS

Intel announces discontinuation of all 9th-Gen Core-X CPUs

Off go the beasts.

Well ahead of their actual discontinuation date, Intel has announced the dates from which you will no longer be able to purchase the 9th-Gen Core-X series processors. This covers all 9th-Gen Core-X chips including the big Core i9-9980XE. These include the boxed and tray versions of the i7-9800X, i9-9820X, i9-9900X, i9-9920X, i9-9940X, i9-9960X, i9-9980XE, and the Xeon W-2102, W-2104, W-2123, W-2125, W-2133, W-2135, W-2145, W-2155, W-2195 chips.

This discontinuation doesn't come as much of a surprise, as Intel has already had its 10th Generation Cascade Lake X chips on the market for quite some time, which includes the mighty Core i9-10980XE.

This discontinuation will take place over the course of about a year. Customers and clients will be able to place their last orders no later than January 22nd 2021, after which any open orders won't be cancelable anymore.

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intel CORE i9 10TH GEN

intel CORE i7 10TH GEN

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TECH BRIEF

macOS 11 Big Sur features

What does macOS 11 have in store?

It's official: macOS 11 Big Sur has been unveiled, and it's well on its way to the public. Recently announced at online-only WWDC 2020, the next macOS will bring some pretty major – not to mention, exciting – improvements to the operating system that powers the best Macs.

Where its predecessor, macOS Catalina, only had minor improvements over macOS Mojave, macOS 11 Big Sur is expected to roll out the biggest changes to Apple's operating system in years. Chief among them is the migration to Apple-designed silicon. This has been rumoured for years, but this, along with macOS Catalyst, will finally bring support for every iOS and iPad app to the Mac operating system. Apple also promises that it will lead to greater efficiency and power.

Alongside some stability improvements, we're also getting a massive redesign in the look of native macOS apps with macOS 11 Big Sur. Apple finally giving apps like Messages, Mail, Photos, Calendar and even Finder a fresh, much more compact and streamlined design. Of course, we're also getting cool new features that are more in line with those on the upcoming iOS 14 and iPadOS 14, with macOS Big Sur bringing widgets. This should make your whole Apple experience a much more harmonious and unified experience. Other key changes include:

Safari

This is supposedly the biggest update the browser has received since it was first introduced. This new version of Safari will bring a host of new features to the table including Intelligent Tracking that can give you a Privacy Report on each website you visit, Save Passwords to track your passwords and make sure they haven't been compromised, Extensions support for WebExtensions API and a new Extensions category in the App Store, and native translation capabilities.

Sidebar in Mail and Photos

The Apple Mail and Photo apps have been out of date for a while now, but Apple has brought new designs to a lot of the biggest Mac Apps, with the most notable ones being the new sidebars in Mail and Photos.

Control Center on Mac

One of the best things about iOS is the super convenient Control Center that lets you change settings at a glance. macOS Big Sur brings that to the Mac, and it's easily accessible in the Menu Bar, so that you can easily change settings without digging through the preferences app.

If you want to download and install macOS 11 when it becomes publicly available later this year, you're going to want to make sure your Mac is actually able to run it. And, unfortunately macOS system requirements have been announced:

- 12-inch MacBook (2015 and later)
- MacBook Air (2013 and later)
- MacBook Pro (Late 2013 and later)
- Mac mini (2014 and later)
- iMac (2014 and later)
- iMac Pro (all models)
- Mac Pro (2013 and later)

While there's no actual release date yet, we should see the macOS 11 Big Sur available to the public in either September or October 2020 if Apple follows its typical release schedule. ■

"Where its predecessor, macOS Catalina, only had minor improvements over macOS Mojave, macOS 11 Big Sur is expected to roll out the biggest changes to Apple's operating system in years."

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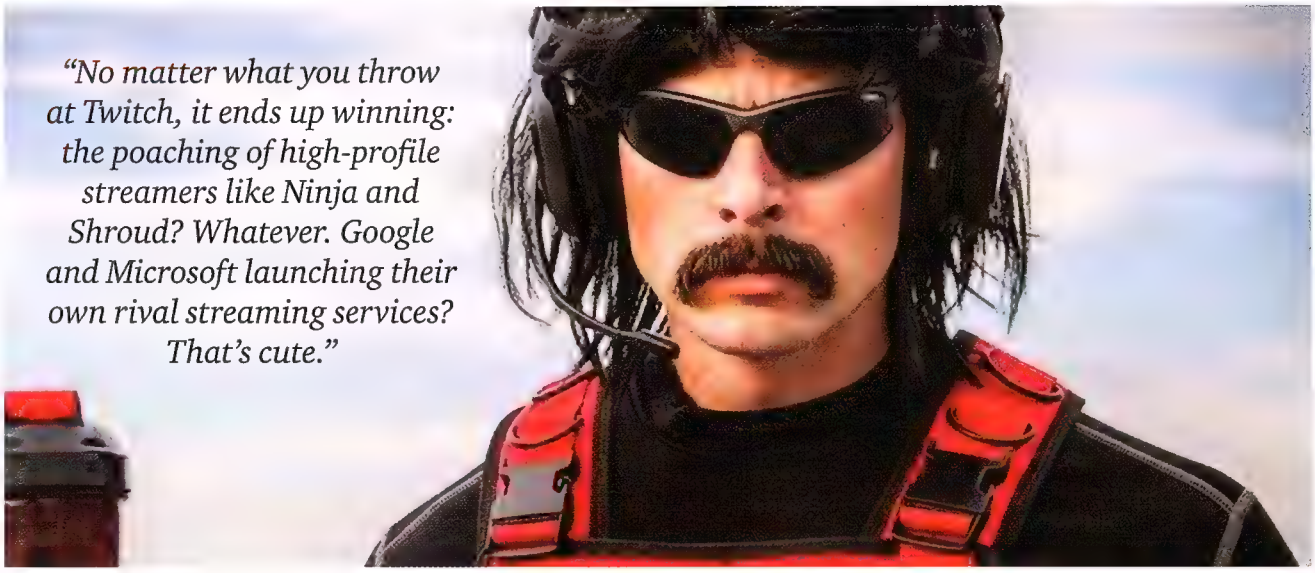

"No matter what you throw at Twitch, it ends up winning: the poaching of high-profile streamers like Ninja and Shroud? Whatever. Google and Microsoft launching their own rival streaming services? That's cute."

END USER

The age of innocence is over for game streaming platforms

Twitch is having to grow up in 2020, writes Shaun Prescott.

Like most powerful developments in media tech, no one took Twitch seriously when it launched in 2011. The typical questions arose, or at least they seemed typical at the time: who on earth would watch someone play video games? Who on earth would waste precious data on that? Live streaming wasn't exactly a new phenomenon back then, but Twitch wanted to make it a big component in our day-to-day media diet.

Nine years later, it's pretty obvious that the company has succeeded – no one would deny that the stakes are high for streaming services with a focus on games. In 2019 Microsoft poached high-profile *Fortnite* streamer Ninja for a reported $30 million. The 29-year-old streamed exclusively on Microsoft's Mixer for less than a year before the company shuttered the marginalised service.

No matter what you throw at Twitch, it ends up winning: the poaching of high-profile streamers like Ninja and Shroud? Whatever. Google and Microsoft launching their own rival streaming services? That's cute. But that inevitably means that the Amazon-owned Twitch is at the forefront of whatever unprecedented controversy may arise in the space, and boy, has 2020 had some tricky ones in store.

Take the recent banning of popular variety streamer Guy Beahm, aka Dr Disrespect. He was unceremoniously booted mid-stream in June, and at the time of writing, no one knows why. There's no shortage of speculation: he's recently incurred bans for broadcasting inside E3's public bathrooms, and in 2017 took a self-imposed hiatus after cheating on his wife. Whether any, all or none of these are related to his current ban, the public doesn't know, but it's left his millions of fans wondering how the world's biggest streaming service can abruptly pull the plug on one of its biggest stars. Will Twitch withstand this growing antipathy? All signs point to: definitely.

Don't underestimate its size: notwithstanding the millions of dollars its brightest talent can make, Donald Trump has a Twitch account which was temporarily suspended in June for violating Twitch's guidelines. "In line with our policies, President Trump's channel has been issued a temporary suspension from Twitch for comments made on stream, and the offending content has been removed."

It's unlikely that Twitch's founders, back in 2011, ever expected to have to wade into territory like this. The US Army even streams on the service, and was recently embroiled in its own controversy. Users were taking to the comments section in order to question – live on air – US Army streamers about US war crimes, and these comments were being promptly deleted. But because the First Amendment forbids government organisations from moderating public speech, some qualified commentators have suggested it could get them in hot water.

That's 2020 for you: the US President has his account on a videogame streaming service suspended for "hateful content", and the US Army allegedly breaches the First Amendment on the same platform that, uh, popularised *Twitch Plays Pokemon*. Meanwhile, US rapper Logic has "retired" from his music career in order to exclusively stream videogames on Twitch, in a deal reportedly worth seven figures.

It's a crazed, sickly media landscape, but you don't need me to tell you that. What seems less obvious but equally inevitable, is that Twitch will come to define the way we consume media – and how we're fed political messaging – in the decade to come. Whether you choose to log in or stay away, Twitch will be unavoidable for the next few years. ■

SHAUN PRESCOTT
Author, PC gamer and passionate technology observer, Shaun covers trending tech topics for *APC*.

RANDOM ACCESS

The untimely death of USB 3.2

We were excited about the display and transfer potential of this new USB specification, but apparently, we're the only ones.

The external hard drive market isn't the fastest developing area of tech, so when something like a new USB specification comes along it can entirely change the landscape. The USB 3.2 spec was announced back in February 2019, but we didn't see any devices with it until WD's Black P50 Game Drive which launched locally in February 2020. At the time we couldn't actually track down any PCs with a USB 3.2 port, so the max speed we could get this backwards compatible SSD to was 950MB/s. Fast forward to today and ... there's still not one laptop on the market that has a USB 3.2 connection.

The USB 3.2 specification hasn't been announced as dead however, it's just kind of been forgotten. A fate that's perhaps worse when you consider we were really excited about it rolling out.

There are a couple of things that stop today's external hard drives from reaching the 2,000MB/s plus read and write speeds you get from internal SSDs, but the main bottleneck is the type of connection. External SSDs generally use a SATA 3 (6Gbps) connection to communicate with your computer, which means you aren't able to get much above 500MB/s read and write speeds. Samsung took a swing at improving this by using the much faster Thunderbolt (40Gbps) connection in its X5 Portable SSD, however the proprietary controllers were pricey so the drive will price most consumers out. Compounding this issues is the fact that Thunderbolt is not used by all the latest PCs, so while it'll work for transferring files from one device, there's a good chance the other one won't be compatible and there's no cross compatibility with USB, so if there's no Thunderbolt, you won't be getting your files. Finally, after about 15 seconds the drive heated up to a point that it needed to throttle itself to be slower than 550MB/s, so in short, Thunderbolt is not a great speedy storage solution.

"The USB 3.2 specification hasn't been announced as dead however, it's just kind of been forgotten. A fate that's perhaps worse when you consider we were really excited about it rolling out."

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

USB 3.2 could, in theory, fix these problems – or at least the vast majority of them – if it was ever actually picked up. The third generation of USB 3 connection adds an additional lane of USB 3.1 (Gen 2) bandwidth to double the throughput from 10Gbps to 20Gbps. This isn't as fast as the 40Gbps you get from Thunderbolt, but USB 3.2 is purportedly cheaper to implement and is fully backwards compatible. This means that a drive like the WD Black P50 can get up to 1000MB/s read and write speeds if you use it with an older USB 3.1 port, and it'll even talk to USB 3 and 2 inputs if it has to.

And we haven't even gotten into the fact that USB 3.2 would be able to supersede the throughput speed of DisplayPort 1.2 specification (17.28Gbps) which would mean you could run your high resolution gaming monitors over sleek new universal cables.

At the moment we don't have any answers for you so we'll just have to leave the question of: What happened to USB 3.2? to be answered in a later installment of Random Access. ■

TWO BITS

Thinking about popping in another M.2 drive?

It's not so plug and play.

It's common wisdom that adding a fast NVMe SSD will greatly speed up the responsiveness of your system. That's definitely the case, but what happens if you insert a second or third drive into your shiny motherboard? All too often, sadly, you have to delve into the depths of the motherboard manual to see if you'll get what you think you'll get. In some cases, a drive or some other system component may not function at all. It's a real mess and I wish the manufacturers made it a little easier for non-expert users to understand. The obvious solution is of course, to add more PCIe lanes!

The problem lies with the CPU manufacturers and their platforms. The desktop Socket 1200 and AM4 CPUs are stuck with a limited number of PCIe lanes, even more so on the budget chipsets. 16 of these lanes are allocated to the primary PCIe slot. The rest are typically routed to a single M.2 slot or the chipset, which in turn has its own set of available lanes.

AMD leads with its PCIe support. Of course its chipsets are configured differently, but the X570 and B550 platforms both support PCIe 4.0, which double the bandwidth of the PCIe 3.0 lanes that Intel use. X570 notably features 24 PCIe 4.0 lanes from the CPU, which is usually allocated with 16 to the primary PCIe slot, four to an NVMe slot and four to the chipset. From the chipset, an additional eight lanes can be used for additional slots or controllers. AMD has it mostly right. A typical system configuration is able to run without compromise.

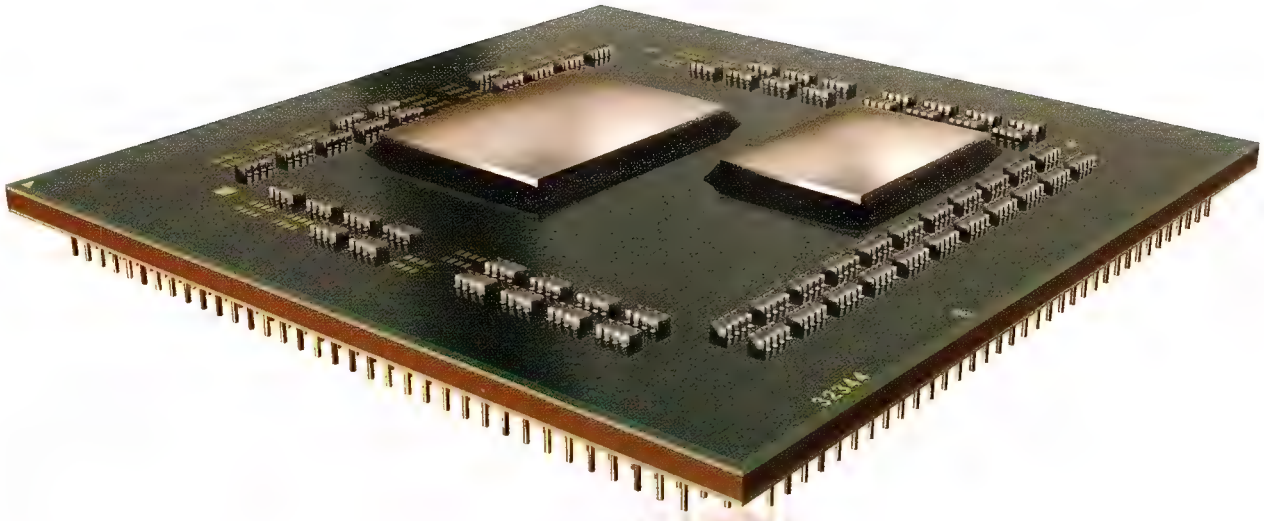
Intel hasn't caught up (officially at least, but PCIe 4.0 on Z490 is a story for another day). It lags behind with ageing PCIe 3.0 support and a relatively slow DMI 3.0 CPU to chipset link. While you can run several NVMe drives, the DMI link can be a bottleneck. Both AMD and Intel desktop platforms can also force disable other components of you run several NVMe or SATA M.2 drives. Usually SATA ports or a PCIe slot is disabled. We deserve better in 2020.

"The problem lies with the CPU manufacturers and their platforms. The desktop Socket 1200 and AM4 CPUs are stuck with a limited number of PCIe lanes, even more so on the budget chipsets."

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

Both Intel and AMD use additional PCIe lanes as a selling point for their high end desktop platforms. If you move up to the HEDT platforms, PCIe lanes are not an issue. The Threadripper TRX40 platform supports up to 72 PCIe 4.0 lanes. That's the bandwidth equivalent of 144 PCIe 3.0 lanes! With that kind of capacity, you can run as many GPUs, SSDs, expansion cards and peripherals as you want. Intel's X299 platform is also well equipped with up to 68 lanes, although they are the slower PCIe 3.0 variety.

If Intel and AMD (and the motherboard manufacturers by extension) want us to pay $500+ for a mainstream motherboard, give us something to justify it! More PCIe lanes please. Let us run two or three M.2 drives at full speed without disabling SATA ports or a PCIe slot. So what if the CPUs need more pins or the socket is larger. If you want us to pay more, give us more! ■



TECH TALK

Over it

Stop with the auto-overclocking.

Recently, AMD X570 motherboard makers came under scrutiny for potentially running the latest Zen 2 CPUs out of spec. Enthusiasts want their PCs to run as fast as possible, and any tuning that a motherboard manufacturer might do in a BIOS is fair game for them. The other take is that any auto-overclocking or beyond-spec tuning should be disclosed in the settings, and by default a board should run at stock.

With AMD's AM4 X570 boards the problem is that some motherboards are reporting an incorrect current (amps) value to the CPU. The CPU uses this value to determine voltage, power, and clock speed, seeking to stay within the specified limits. If the motherboard "lies" and says the current is lower, then the CPU will be able to exceed the normal power limits and potentially run faster.

This technically voids your AMD CPU warranty, just like Precision Boost Overdrive. Whether or not these hacks could cause a CPU to fail is more difficult to nail down. Long term, Zen 2 CPUs built on TSMC's 7nm lithography might be more at risk than 12nm and 14nm chips, but it would still likely take years for most CPUs to fail.

There are some other consequences, however. The biggest is CPU power use, which directly translates into heat. If you're running a four-core or six-core 3rd-gen Ryzen, there's probably nothing to worry about – even eight-core Ryzen 7 3700Xs should be okay. Instead of 65W, your CPU could potentially use as much as 95W, which is well within the limits of what the silicon can handle. No big deal. But with a 105W 3800X, 3900X, or 3950X, power use could be substantially higher. We're talking 160W during "stock" operation, and at least one vendor (Asrock) has some boards that can hit as much as 210W of power draw – all on the CPU.

With proper cooling, it's still unlikely to cause any serious issues in the near term. However, some users have noticed substantially higher temperatures on high-end 3rd-gen Ryzen processors, as the Wraith Prism potentially struggles to dissipate 150W of power. Other CPU protections kick in, and "throttling" may occur to keep the CPU below 90 C or whatever, except in this case the throttling is probably just moving the CPU back toward running at official speeds and power. Still, 90 C and higher temperatures are a serious concern, so a user might end up buying a more expensive cooling solution just to keep things running properly.

I've seen test results where on some boards the "stock" performance is higher than what can be achieved with PBO, meaning the motherboard vendors are overclocking via the amperage cheat more than you can get with PBO. Interestingly, enabling PBO appears to disable the erroneous amperage reporting, so vendors were smart enough to know that double-overclocking is a bad idea.

"This technically voids your AMD CPU warranty, just like Precision Boost Overdrive."

JARRED WALTON
There's nothing Jarred likes more than deep diving into how tech works.

But let me get back to the bigger picture. While AMD boards are the most recent example, they're by no means alone. Intel doesn't even report official all-core turbo clocks any longer, basically letting motherboard vendors run free. There are Z490 boards for the new Comet Lake CPUs that will run the Core i9-10900K at 250W, indefinitely – assuming that your cooling can keep up. Perhaps even worse, I remember testing the first Skylake-X CPUs a few years back, and seeing system power draw during a Cinebench run eclipse 450W with a Core i9-7900X. Even liquid cooling failed to keep up, and I watched power steadily go up until the system eventually crashed!

Frankly, I'm tired of these shenanigans. I understand the desire to make a board appear better than the competition, and I'm not even opposed to auto-overclocking features. Just at least give us a way to run a CPU at fully stock specifications. Because sometimes we actually want to respect the official TDP constraints. ■

OPEN SOURCE

Super boot

One boot.

How many boot disks do you have lying around your desk? Maybe you have a whole drawer stuffed with burned optical discs or USB flash drives, struggling to remember what bootable medium is on what, or you've tried to make do with two or three drives, swapping ISO images in and out.

Whatever your method, it's a pain keeping tabs on them all. Optical discs are – by their nature – slow to boot and obsolete the moment a newer version of the bootable media in question is released. As flash drive capacities grow ever larger, it seems wasteful storing a single 512MB bootable rescue disk on a 16GB drive. Wouldn't it be great if you could house all your boot disks on a single USB flash drive, then switch between them as required?

Your prayers have been answered. With Ventoy, a new open-source boot tool, you can store multiple boot images on a single flash drive, then choose which one to boot from a start-up menu. It's simple to get up and running: Head to **www.ventoy.net** and click "Downloads" where you'll find downloadable installers for Windows and Linux.

For Windows, download and extract the zip file's contents, and double-click "Ventoy2Disk.exe." You'll need a single blank USB flash drive – the larger the better. It should be detected automatically (click the "Device" drop-down menu if not). By default, support for secure boot is disabled; switch it on via "Option > Secure Boot Support" if necessary, then click Install to format the drive and set things up.

Then, drag bootable installers in ISO or WIM format onto your flash drive – over 260 are officially supported, but many more should work. Reboot your PC from the USB flash drive to view a list of the copied files. Select one, and it should boot as if you'd created a standalone boot disk for it.

If secure boot is enabled on your PC, you'll need to follow a one-time procedure outlined at **www.ventoy.net/en/doc_secure.html** – if successful, you're laughing, but I was unable to get the key enrolled on my MSI X470 Gaming Plus motherboard when I enabled secure boot. Disabling secure boot meant the drive worked flawlessly.

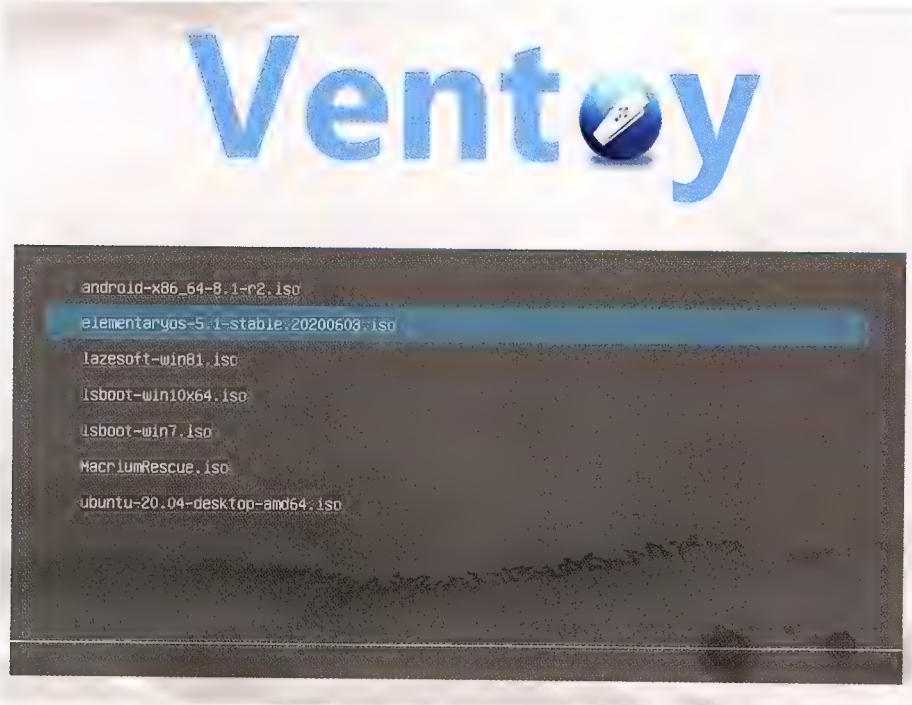
The benefit of Ventoy is obvious – in my case, I can bring together my various install media (Windows 10, Ubuntu, elementaryOS, and so on) together with a selection of rescue discs, including Macrium Reflect and Lazesoft Recovery Suite, onto a single 16GB flash drive.

When your boot media is updated, download the latest version and either replace the older version with it or run multiple versions side by side for compatibility purposes across your machines. You're only limited by the size of your flash drive.

Ventoy itself is also undergoing rapid development – secure boot was only added in version 1.0.7, for example, while support for persistence across multiple live OSes without having to partition the flash drive arrived in version 1.0.11. The Linux install process is convoluted at the time of writing, but a GUI is already being developed by a third party so don't be surprised to see a GUI option appear for setting up Ventoy on your Linux PCs too. ■

NICK PEERS
Nick has been dabbling with Windows, Linux, macOS, Android and iOS since forever.

" With Ventoy, an open-source boot tool, you can store multiple boot images on a single flash drive, then choose which one to boot from a start-up menu."

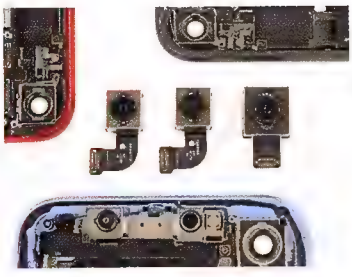


Multiple boot media on a single USB flash drive, thanks to Ventoy.

HOW IT'S DONE

TAKING THINGS APART AND HAVING A POKE AROUND

Sometimes when tearing down iPhones, we get a little board. Like this one!



Left: iPhone SE. Middle: iPhone 8. Right: iPhone XR.

iPhone SE 2020

Reading its entrails.

Second Edition? Smallish Edition? We're not sure what "SE" stands for, but it wouldn't be an iPhone teardown without a little mystery. And this 2020 iPhone SE is $700 worth of smartphone conundrum – old-school on the outside and purportedly pretty modern on the inside. Let's tear down…

Major tech specs

- A13 Bionic SoC with a third-generation Neural Engine
- 4.7-inch Retina HD display with 1334 × 750 resolution (326 ppi), True Tone, and wide color gamut (P3) support
- 12MP wide-angle rear camera at f/1.8, and a 7MP f/2.2 front-facing camera
- Gigabit-class LTE with 2x2 MIMO and 802.11ax Wi-Fi 6 with 2x2 MIMO + Bluetooth 5.0 + NFC
- Home button with 2nd-generation Touch ID sensor
- IP67 dust/water ingress rating

Key findings

- The new SE is slightly smaller than the 11 Pro, but what you really notice is the weight difference – the SE is 21% lighter. First we submit the SE for X-ray inspection along with its predecessors, the original SE and iPhone 8. Apart from a very subtle antenna rework and moving a few chips around the logic board, we can't tell what Apple's been up to yet.
- We'll keep the iPhone 8 comparison going and see just how similar these phones are. With both phones open, they look like doppelgängers. Cross-compatible parts could be a real boon for third-party repair. The Taptic Engine and main speaker are interchangeable between the 8 and SE.
- Turning to the battery, the capacity is the same as in the iPhone 8 at 6.96 Wh. That's up from the original SE's 6.21 Wh, and much lower than the iPhone 11's 11.91 Wh. Unfortunately, the connector has changed, so batteries cannot be swapped between models.
- When Apple retired 3D Touch in the iPhone 11 Pro series, it made the displays thinner and batteries thicker. The new SE also lacks 3D Touch, but the batteries are the same size. What was the sacrifice for? Probably to save money. Or Apple wants us to forget that 3D Touch ever happened.
- Where does the main camera come from? Half the rumors say iPhone 8, half say XR, and a forbidden third half say something else. The SE's sensor is smaller than that in the XR. It's likely an iPhone 8 sensor with A13 image processing.
- Back to that display – the iPhone 8 display looks identical to the SE's. Are they secretly the same? Not so fast! On 3D Touch screens, we'd normally find a chip on the back that drives the parallel plate capacitors. The iPhone SE display doesn't have that chip. And the layer of capacitors? We start peeling off parts in an attempt to confirm… no 3D Touch. The two displays are functionally interchangeable, which is amazing considering the difference in hardware.
- Repairability score: 6 out of 10 (10 is easiest to repair). The two most commonly replaced components, display and battery, are straightforward to access with the proper tools. Most components are modular and independently replaceable, including many that are cross-compatible with the iPhone 8. IP67 seals complicate repair. While overall it is repair-friendly, you'll still need up to four different driver types, and the glass back is impractical to replace. ■

The SEquel to the popular budget-friendly iPhone has finally arrived. It's been called a "parts bin" phone, and we really hope that's true! The specs certainly seem to agree with that.

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Eight seriously gaudy PC components

08

Cougar Conquer 2

We'll be honest, the Conquer 2 case absolutely terrifies us. It looks like the decapitated head of a particularly nasty Decepticon, and we want it gone.

07

upHere CCF150CF

The product description claims this is merely a CPU cooler, but we're more inclined to believe that it's actually some kind of alien hand grenade.

06

Asrock Radeon RX 5700 XT Taichi X 8G OC+

This (admittedly pretty good) GPU inexplicably comes with two plain black fans and one completely bedecked with RGB lighting.

05

Lian Li PC-CK101

Yeah, we've got nothing. It's a little train, with USB ports and space inside for a compact ITX system. It also costs hundreds of dollars. What?

04

Team group T-Force Delta Max RGB SATA SSD

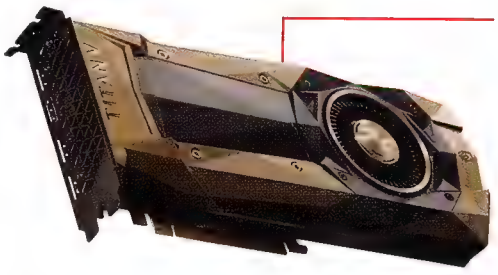
RGB lighting on your SATA SSD, a component that's often tucked away behind the motherboard? Seems pointless, but Team Group did it.

03

Deepcool Gamer Storm Captain 240PRO V2

Despite having the most incredible name, this AIO cooler has an ugly cubic pump covered in pointless pieces of light-up plastic.

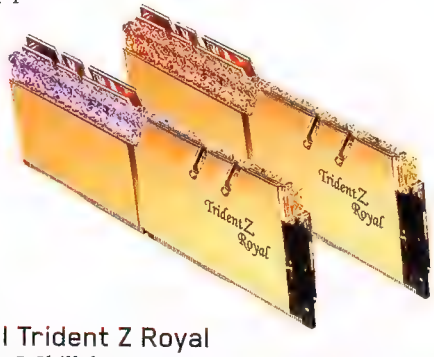
02



Nvidia Titan V

We've all heard about it. Of course, Nvidia had no choice but to cover this monstrously expensive and powerful graphics card with fake gold.

01



G.Skill Trident Z Royal

We love G.Skill, but we never want to see this again. It looks like a stick of RAM made sweet, technological love to a Fabergé egg, and this was the result. ■

WLAN MESH

Mesh WiFi with FRITZ!

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GADGETS

NICE THINGS TO HAVE, FOR YOUR PC AND BEYOND

$2,799 | samsung.com/au

Samsung Odyssey G9

Let this curved monitor take you on a journey.

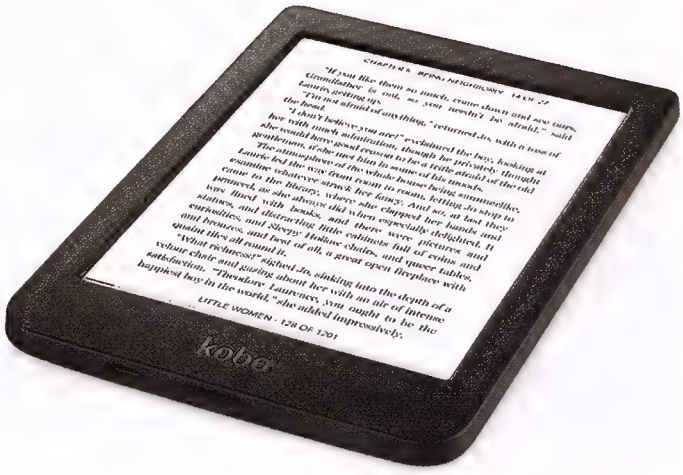
While 49-inches isn't all that big for TVs these days, it's immense for a monitor. The ultra-wide dual quad-HD display has a resolution of 5120 x 1440 pixels (essentially two QHD monitors side by side) and it'll wrap you at a tight 1000R curvature so that each part of the display is the same distance around you. The G9 gets one of Samsung's QLED panels which has a typical brightness of 1000nits (double the brightness of most gaming monitors) and comes with decent HDR capabilities since it hits 95% of the DCI-P3 colour gamut. It even utilises a 240Hz refresh rate with and has a GTG response time of less than 1ms.

$399 | blazepod.com

Blazepods

The PT equivalent of endless fetch quests.

While most of us were already carrying more weight than we'd like before lockdown, the additional freedom to stay at home all weekend and watch Netflix without judgement means we're carrying even more now. So the time is ripe to spend money on fitness tech that you'll use for a month then relegate it to the back of a cupboard until the next council clean up. The Blazepod is an expensive set of flashy lights that can be configured to light up according to an app running a set of proprietary training regimes. So we couldn't think of a better fitness-fad-filler to throw money at right now.



$149.95 | au.kobobooks.com

Kobo Nia

Nia enough is good enough for us.

If you're looking for an entry level e-reader to get you started on your digital library, Kobo's Nia is a worthy competitor to the entry level Kindle. For starters the Nia has a 212ppi 6-inch display, which is 21 percent sharper than what you get on the basic Kindle, but you'll also get access to the Kobo library of eBooks, which is as extensive and – sometimes – better priced than Amazon's library. The Nia comes with 8GB of onboard storage, which allows you to store something like 6,000 books, and while it can't adjust the warmth of the screen, it does at least offer a backlight for reading in dark environments.

Shock'N'Rock for Nintendo Switch Lite

Add some weight to your gaming with

US$25 | nkyo.com

If you opted for the stingy version of the Nintendo Switch, but realised too late that you'd forgotten to consider you'd lose rumble feedback, we can't offer you the ability to return to an earlier save point in your life, but there is at least the Nyko Shock'N'Rock attachment for the Switch Lite. At US$25 plus tax and international shipping we expect this device to cost you about half the amount it would have originally to get the full Switch experience, but we're not even sure how you'll get it here since there doesn't seem to be any option to ship it to Australia.

$449 | klipsch.com.au

Klipsch T5 II True Wireless Earphones

Forget flawless connectivity – carbon fibre casing and self-drying buds are where it's at.

Despite the fact that we can't seem to find a pair of true wireless buds that reliably connect to a smartwatch to stream Spotify on a run without dropping out every 30 seconds, there seems to be a never ending rollout of new devices offering revolutionary advancements like... ah, an automatic sweat drying case. Yep you heard correctly, the Klipsch T5 II come with their very own sauna for your buds to air-dry their bits, which means all those Sweaty Bettys out there don't have to go to all the effort of dabbing them with a shirt or towel before packing them away.

$59 | tp-link.com

TP-Link Kasa Smart Wi-Fi Power Strip KP303

Everything gets smart.

If you haven't embraced the joys of smart home devices that can also be voice controlled, well, get with the program, people. But, wait, you're perfectly happy with the appliances you have – smart or not? With this, you can make anything smart. Each power plug is an independently controllable Wi-Fi outlet, and you can hook it all into your preferred smart assistant. "Hey Google, turn on my Breville kettle that was manufactured in 1953!" And it will happen! Miracles do exist. It's also a handy-dandy USB charger, with a pair of always-on USB ports. ■

REVIEWS

THE HOTTEST GEAR LABS TESTED

$809 (3900XT), $645 (3800XT), $399 (3600XT) | amd.com

AMD Ryzen 9 3900XT, Ryzen 7 3800XT and Ryzen 5 3600XT

Ryzen XT underwhelms with small gains and a big price tag.

AMD's new Ryzen XT lineup comes as a refresh that's designed to tackle Intel's new Comet Lake processors. The XT family brings three new flagships to bear: the Ryzen 9 3900XT, the Ryzen 7 3800XT, and the Ryzen 5 3600XT. Surprisingly, on the surface, the XT lineup looks a lot like what we've seen in the past from Intel: an iterative lineup of chips with small differentiation from their predecessors in terms of features and clock speeds, not to mention the same number of cores, same process node/density (albeit with some refinements), and the same microarchitecture as their predecessors.

AMD even eliminated bundled coolers from two of its three new models, which runs counter to its standard value proposition of throwing in all the goods with each chip. Overall, the Ryzen XT series doesn't appear to have the explosive gains like we're used to with AMD's gen-on-gen improvements, but there's a lot more nuance to the XT story than what we see on the spec sheet.

Turning it up, a bit...

A quick glance at the spec sheet shows most of the key specifications remain unchanged, with the most substantial change being that the 12-core 3900XT comes with a 100MHz higher boost, the 8-core Ryzen 7 3800X gains 200MHz, and the 6-core Ryzen 5 3600XT gains 100MHz.

Due to refinements to the 7nm node, AMD says it improved boost frequencies by 2-4%, but it also improved boost residency, or how long the processor remains at its boost frequency, by up to 80%. Combined with the incrementally higher clock speeds, AMD says the improved boost residency improves lightly-threaded performance by 4-5%.

The minor increases to boost frequencies that we see on the spec sheet don't take into account that the processors now have more room to boost higher in mid-threaded workloads (those that don't fully saturate all of the cores). That capability delivers up to 10% more performance in some workloads, but we found those are pretty rare. AMD wrung out this extra performance while leaving key power limitations unchanged, meaning you get more performance within the same maximum power envelope.

We also see some gains in gaming performance, albeit not of the explosive sort. AMD says you can expect about a two percent improvement with the 3900XT and a four to five percent improvement with the 3800XT, depending on the title. We didn't see as much uplift, though. As expected, games that respond to lightly-threaded performance benefit the most, so gains can be scattered.

Who is it for?

AMD advises that these processors aren't meant to be a direct upgrade path from existing Ryzen 3000 processors. Instead, the existing chips will still be available at retail. The new XT-branded chips will serve

"AMD says you can expect about a two percent improvement with the 3900XT and a four to five percent improvement with the 3800XT, depending on the title. We didn't see as much uplift, though."

XT SERIES	RRP	CORES / THREADS	BASE / BOOST GHZ	TDP	L3 CACHE
RYZEN 9 3900XT	$809	12 / 24	3.8 / 4.7	105W	64MB
RYZEN 9 3900X	$779	12 / 24	3.8 / 4.6	105W	64MB
RYZEN 7 3800XT	$645	8 / 16	3.9 / 4.7	105W	32MB
RYZEN 7 3800X	$609	8 / 16	3.9 / 4.5	105W	32MB
RYZEN 5 3600XT	$399	6 / 12	3.8 / 4.5	95W	32MB
RYZEN 5 3600X	$399	6 / 12	3.8 / 4.4	95W	32MB

		Ryzen 5 3600XT	Ryzen 7 3800XT	Ryzen 9 3900XT	Core i5-10600K	Core i7-10700K	Core i9-10900K
Cinebench 20	Multi thread Score	3,874	5,125	7,305	3,595	4,970	6,659
Cinebench 20	Single thread Score	534	548	547	504	525	535
Adobe After Effects	CC Render Note	NT	1,016.0	1,095.1	NT	1,084.0	1,101.0
7Zip	Million Instruction per second	53,550	66,663	84,544	45,169	61,469	61,235
Average Power Consumption	Watts	84	101	117	107	147	199
3DMark Fire Strike Physics		21,086	25,728	29,993	20,130	25,122	29,607
Far Cry 5	1080p, Ultra, DX11, Avg FPS	120	124	121	131	137	145
Hitman 2	1080p, Ultra, DX12, Avg FPS	100.2	101.1	102.0	101.4	104.4	122.3
Grand Theft Auto V	1080p, Ultra, DX12, Avg FPS	162.2	164.8	166.8	166.8	178.3	174.2
Civilization VI	1080p, Ultra, DX12, AI Turn Time	6.32	6.15	6.21	6.27	6.04	5.87
Final Fantasy XV	1080p, Standard, Avg FPS	163.0	163.5	168.2	160.7	163.4	168.1
Project Cars 2	1080p, Ultra, DX12, Avg FPS	119.8	123.6	122.0	132.2	142.8	149.9
3DMark TimeSpy CPU		7,627	10,349	12,156	7,847	10,475	12,365
Ashes of the Singularity: Escalation	1080P, CRAZY, DX12, AVG FPS	45.4	48.7	48.4	43.4	55.6	56.4
Dawn of War III	1080P, ULTRA, DX11, MAX FPS	112.2	113.4	108.9	113.7	120.8	123.3

"Our testing found that Intel still holds the overall single-threaded crown when we look at a broader spate of workloads and data types. However, AMD has significantly increased both its boost speed and boost duration with the XT models."

as another choice for customers if they're upgrading to a Ryzen processor for the first time, or refreshing an older rig.

You'll need to bring your own 280mm (or greater) AIO liquid cooler for Ryzen XT 9 and 7 chips, though, which adds to the pricing significantly. We did record slightly improved performance from the auto-overclocking PBO feature over prior-gen models, but AMD also says you shouldn't expect higher manual overclocking frequencies from the new chips.

Overall the Ryzen XT processors offer incremental performance increases in gaming that aren't worth a direct upgrade, and most gamers are better suited with either AMD's existing models or Intel's competing chips – the Ryzen XT series doesn't change the gaming landscape much. If gaming is your primary focus, you'll be better served with less expensive Ryzen alternatives, like the Ryzen 7 3700X or the Ryzen 5 3600X. The Core i5-10600K is another solid choice.

Due to the performance characteristics of the XT models, they're a decent step up over the standard models if you frequently use productivity applications that aren't exclusively heavily-threaded. The Ryzen 9 3900XT and Ryzen 7 3800XT, in particular, deliver great gains in a few productivity apps, like Photoshop and Adobe Premier, so paying a bit extra for the chip only makes sense if you already plan on using an aftermarket cooler and use those types of apps almost exclusively.

AMD claims the 3900XT now holds the single-threaded performance crown, wresting it from Intel's aging Skylake architecture, but it's noteworthy that distinction appears to be based specifically on Cinebench benchmarks. Our testing found that Intel still holds the overall single-threaded crown when we look at a broader spate of workloads and data types. However, AMD has significantly increased both its boost speed and boost duration with the XT models.

Conclusion

The Ryzen XT lineup arrives to do battle with Intel's Comet Lake, but while the new chips do provide measurable performance gains over their predecessors, you'll need to run very specific workloads to justify the increased costs associated with the cooler-less Ryzen 9 3900XT and Ryzen 7 3800XT. That's complicated by the fact that the existing X-series models already retail at great price points, giving AMD plenty of competition from within its own ranks.

The Ryzen 5 3600XT looks promising if it falls to a lower price point, especially in light of its bundled cooler, but we'll follow up with more targeted testing in a separate review.

There are places where the 3900XT and 3800XT might make sense despite their higher pricing, but for the majority of enthusiasts, gaming isn't one of them. Overall, the Ryzen XT series does provide another option for discerning shoppers that know their workload, particularly those that frequently use applications that benefit. Still, most will be better served with AMD X-series processors or Intel alternatives.

PAUL ALCORN

AMD's XT-series brings improvements to lightly- and mid-threaded performance to bear, but the gains are minor enough in most applications that it isn't worth the high price and associated cost of an aftermarket cooler, especially in light of the value of AMD's own X-series processors.

★★★½☆

"Unlike many siblings and rivals, this high-end unit doesn't look like an ostentatious, spiky spaceship that takes up heaps of desk space."

apc RECOMMENDS

$519 | www.asus.com/au

Asus AX5700 Dual Band RT-AX86U Gaming Router

A well-specified, high-performance router that's targeted at gamers but will find broader appeal.

Asus has been kicking goals in the land of Wi-Fi 6. The company offers some of the best high-end routers, some of the best budget routers, some of the best Wi-Fi mesh systems and some of the best gaming routers. The RT-AX86U is Asus' latest of the latter and first impressions were good.

Unlike many siblings and rivals, this high-end unit doesn't look like an ostentatious, spiky spaceship that takes up heaps of desk space. Only three external antennae protrude from the top of the relatively discreet, vertically-oriented chassis. These combine with a 1.8GHz quad-core processor plus 1GB RAM to achieve theoretical dual-band speeds of 5,700Mbps. We used our usual test methodology to establish its real-world performance by downloading large files from our Synology DS1019+ NAS to a Dell XPS 15 OLED laptop in a three-storey Sydney townhouse with the router on the ground floor. Up close it managed a stonking 799Mbps transfer rate – the fastest Wi-Fi speed we've ever seen. This dropped to a (still-impressive) 311Mbps one floor up, before managing 104.3Mbps two floors up. While the performance drop-off is significant, it's far from slow and you can use other Asus AiMesh-technology equipped products to boost long-range performance.

Asus' well-featured phone app offers quick-and-simple set-up, decent monitoring options, plus access to the most important settings. There's also an 'innovative' one-click Mobile Gaming Mode though we couldn't detect it making a significant difference. This is the type of feature-packed device that's worth using a full, desktop web browser to access the full complement of firmware features. Aside from excellent QoS and parental controls, there's the usual (for Wi-Fi 6 routers) Trend Micro-based network security. We particularly liked the port forwarding section which, finally, has an extensive list of games (and platforms) ready for one-click optimisation.

Other features make use of the hardware ports. Here a Gigabit WAN can be combined with one of the four Gigabit LAN ports to provide a 2Gbps, dual internet connection that you can connect to via the additional 2.5Gbps Ethernet port. Alternatively, you can use the 2.5Gbps port as an internet source. There are also two, USB-A 3.2 Gen1 ports which can be configured to work in multiple ways: storage devices can be transformed into a file server or media server (including iTunes), it can also be used as a print server, 4G internet fall-back, Time Machine backup and even a PC-free, Bittorrent-compatible download manager.

SPECS
Dual-band AX 5,700Mbps
Connectivity: 4 Gigabit LAN, 1 x Gigabit WAN, 1 x 2.5Gbps WAN, 2 x USB-A 3.2 Gen1 ports
Features: Parental controls, QoS, Mobile Game Mode, AiMesh, Lifetime Trend Micro Internet Security

It all amounts to a very well featured, very fast, gaming-oriented router, but at a hefty $519, it won't be for everyone. If you just want Wi-Fi 6 beamed around your house with a single router, TP-Link's similarly priced Archer AX6000 offers better performance at long range, albeit at the expense of blistering, close-up pace and the gaming-oriented bells and whistles. If you want the features and the range, Asus' own colossal, ROG Rapture GT-AX11000 can now be found for under $700. However, if you want to save money, while maintaining decent Wi-Fi 6 performance, Asus' budget friendly (and budget-looking) RT-AX3000 can be had for $378.

NICK ROSS

High-end features and blistering close-range performance will suit demanding gamers. But it's overkill for most users.

★★★★☆

$250 | www.dlink.com.au

D-Link EXO Smart AX1560 Router

The cheapest Wi-Fi 6 router that we've yet seen. However, there are compromises at this price.

In *APC* 482, TP-Link dazzled us with its boring-looking Archer AX50 Wi-Fi 6 router which offered speedy 802.11ax wireless technology in an uninspiring box that cost under $300. Up to that point, the Wi-Fi 6 market had seen Asus and TP-Link seeking to out-do each other by offering increasingly powerful UFO-lookalike devices for nearer $1,000. But the market is maturing and now here's D-Link (finally) with a Wi-Fi 6 router that can already be found under $200. Should you buy it?

First up, this really is dull-looking. All effort has gone into the function-based value proposition with little attention being paid to form: it's an unattractive, dual-band, Wi-Fi 6 black box with four spindly antennae.

Set-up is very simple thanks to the D-Link Wi-Fi app and a QR code (in the box) which walks you through the connection. After you choose the network name and password (the 300Mbps 2.4GHz band and 1,200Mbps 5GHz bands are combined into one) you choose a device administrator password and you're up and running. If you log-into an optional D-Link cloud account you can set up Google Assistant and Amazon Alexa voice commands which enable you to disable connectivity, check login credentials and reboot the system.

The app is simple to use and allows you to easily see which clients are connected, enable guest Wi-Fi, turn off the four, bright, status LEDs, update the firmware and set parental controls. The latter lets you set-up different profiles which enable different devices to access the internet at different times of the week. We were pleased that it allowed us to make the choice in 30-minute increments as the commonly-used hour-long delimiters frequently aren't compatible with small-children's bed time routines.

This is all standard fare for Wi-Fi 6 routers. In fact, this is the first such device we've seen without built-in Network security but then there's got to be some compromise at this price. So, what about performance?

We ran our standard suite of Wi-Fi tests, which involve downloading large video files from a Synology DS1019+ NAS to a Wi-Fi-6-equipped Dell XPS 15 OLED laptop in a three-storey Sydney Town House. Up close it achieved the second fastest transfer rate we've ever registered: 735.3Mbps! However, this isn't uncommon for the cheaper routers at short-range: the persistent issue is that of signal degradation over distance and this was the case for the D-Link. One floor up, transfer speeds collapsed to 61Mbps and even that took two attempts to achieve (the first effort managed 30Mbps). Two floors up it was scored just 22.5Mbps which is in keeping with mediocre wireless AC-technology devices of a few years ago.

But you can't have everything. The RRP of the DIR-X1560 is just $250 and it can be found online for just $189 already. If you want no frills, fast Wi-Fi on the cheap, and aren't too fussed about range, it's a great buy. However, TP-Link's slightly dearer, Archer AX50 will appeal to those who need better performance at range while still on a budget.

NICK ROSS

SPECS

Speed: Dual-band AX 1,500Mbps; Connectivity: 4 Gigabit LAN, 1 x Gigabit WAN; Features: parental controls, Google Assistant & Amazon Alexa support.

Cheap and relatively cheerful, D-Link's no-frills Wi-Fi 6 router undercuts the competition on price, but offers limited range.

★★★☆☆

$3,198 | acer.com

Acer Predator X38

When everything comes together in a supreme package.

The Acer X38 is without doubt a contender for Best Monitor Right Now. It ticks a *lot* of boxes. It's enormous, at 37.5-inches in a glorious 21:9 aspect ratio with a 3840 x 1600 resolution. It's curved, though only a little bit at a relatively relaxed 2300R bend, but still enough to have each edge come in at you just enough to make taking it all in quite natural. The panel is IPS, which is what you want for luscious colours, and Acer has overcome the big IPS downside of typically high response times. This beast has a 1ms GtG response, which is truly IPS coming of age and doing it all without the compromises of old.

It's G-Sync, and also HDR 400, with all this ripping along at a stock refresh of 144Hz, which can be cranked up to 175Hz. There is almost nothing on the screen technology tree that this monitor doesn't sport. Which is why it is also expensive, at $3,198.

First impressions are very good, thanks to an unusually pleasant unboxing and setting up process. It's surprisingly light for a monster this size at just 9.48kg – and that includes the big metal stand, which comes fitted, another nicety. The extra, raised, VESA plate for arm or alternative mounting also looks very sturdy indeed. Monitor cable connecting is usually a minor fiddle with difficult to reach and see recessed ports, but the X38 tilts back a full 35 degrees, exposing its display and power ports underneath for effortless no-fumble plugging in. Once settled in, the screen raises, lowers and rotates and of course tilts to a generous degree, far more than most. The extra rotation means you can position the stands at an angle to keep one of the legs from interfering with your mouse pad if you like it up close, and just rotate the screen back to face you. Nice. The screen also raises or lowers 13cm, which, again, is very generous.

"No matter what you're coming from, 37.5 inches is just mammoth. It simply isn't possible to take it all in without moving your head slightly."

I did find that when using the HDMI port, any movement of the monitor would cause the screen to flicker or momentarily go dark – a dodgy port, no doubt, and hopefully particular to just my review unit. The DP port is fine.

A pair of small 7w speakers are built-in, though anyone that buys this will have a superior audio solution, no doubt. The X38 is unadorned with RGB bits behind it that you'll never see anyway.

No matter what you're coming from, 37.5 inches is just mammoth. It simply isn't possible to take it all in without moving your head slightly. That means immersion, of the maximum variety. The skinny little bezels are just 2mm wide and blend into invisibility in use.

UI controls are around the back and work well enough. Switching between inputs does take a frustratingly long time, and adjusting the brightness is trickier than it needs to be, but it's generally well laid out and accessible.

As a general productivity monitor this thing is a dream. The size obviously makes things possible you just can't do on anything lesser. It can fit four A4-sized windows side by side. FOUR! Or, Satan's own spreadsheet filling up the entire

SPECS
37.5-inch; 3840x1600 @ 144Hz, 175Hz OC; 21:9 aspect; 1,000:1 contrast; 1ms response; IPS panel; 1x HDMI, 1 x DP 1.4, 1 x USB 3.0 upstream, 4 x USB 3.0 downstream; Nvidia G-Sync; HDR 400.

expanse. I've been using it during the day for desktop graphic design while also writing and emailing, and have ample room to spare. Text shows up crisply with no jaggies or bleed, and it's very unusual to have a large gaming monitor achieve that. A proprietary blue light mode reduces eye strain, too, and it works very well, at least as good as a Microsoft Surface screen, which I think is the best in the biz for good blue light reduction. Colour accuracy is also very good, at 98% DCI-P3. You can also select how the LED backlights operate, with Desktop, Gaming and Hybrid modes. In practise I saw no discernable difference while gaming, and generally left it on Desktop mode unless in a fast-paced FPS game.

But this thing wasn't built for word processing. In games there simply isn't anything better. It is a gaming dream where the many technologies that you might see one or two of in a monitor all come together, leaving you wanting for almost nothing more.

The ultrawide aspect ratio makes it extremely well suited to driving games, and while it might not have the extreme width of something like a Samsung CRG9 49-incher, its 1600 vertical res is more useful than the maximum 1440 of that Samsung model, or paltry 1080 of its still-popular 49-inch predecessors. Indeed, it's the 1600 vertical res that makes this really shine as a gaming screen – every ultrawide monitor we've reviewed so far is lacking in that department and having as much tall as you do wide really opens things up both viscerally, and for better usability.

FPS gaming is an immersive wonder. In *Doom Eternal* the experience was almost overwhelming and seeing the colours of this IPS in such a sumptuous environment was an eye candy deluxe thrill. It doesn't quite dazzle like a quantum dot screen – again Samsung does slightly better with that technology across its recent gaming screens – but there's little to complain about. At HDR 400, it's good enough to deliver what you want in HDR effects, but it's not dazzling like the HDR 1000 screens you can now buy, such as the Asus PG43UQ.

Banding was pretty much non-existent and the backlighting was even, though with a faintly noticeable glow coming from the edges in dark scenes, but nothing to be troubled about and not noticeable at all while gaming.

The Acer Predator X38 is an imposing behemoth with every important screen tech packed in – which is exactly what you're paying top dollar for.

Pushing the overclock to 175Hz yielded a perfect result with no ghosting visible. Small details like text were rock solid, too, with no shimmering. At such a huge resolution your graphics card will obviously be taxed in many games, and for me while testing this I generally left it at 144Hz, though for several days I used it on 175Hz for everything – including boring work – and it was rock solid and crisp.

There's little more you could wish for with this. We've been waiting a long time for a monitor that had actually-useable vertical resolution to match the width. Until now if you wanted wide you had to settle for short. Now it's all come together, and with a grab bag of the best in screen tech to boot. Yes, the HDR rating could be higher, but it's a small compromise in the face of all the gains elsewhere. Best of all it's the first of its type that's truly useable for eight hours a day doing work. Again, those extra vertical pixels make a huge difference for that.

Acer's done very well putting this together. It's not cheap, but that's hardly surprising considering the package you get.
BEN MANSILL

Everything desirable in a super-high-end monitor packed in together, the Acer Predator X38 is a dream come true and the 1600 vertical res is what we've been waiting for especially.
★★★★½

$195 | www.samsung.com

Samsung 870 QVO 1TB

A storage SSD?

While NVMe drives get most of the attention these days, there's still a market for SATA drives that continues to encroach on the mechanical hard drive space. The Samsung 870 QVO is exactly what the doctor ordered as a storage SSD. The problem is that SATA SSDs are almost commodity products. Performance isn't much of a factor in 2020 so it comes down to other features such as endurance, warranty and of course, pricing. Can Samsung's second generation QLC drive add another nail in the coffin of mechanical hard drives?

The key characteristic of the 870 QVO is its Quad Level Cell NAND. QLC tends to be slower and typically has a lower endurance rating than the TLC NAND found in many budget-oriented consumer SSDs. Its advantage is its higher density, which should mean better affordability. This higher density is a key, and Samsung is due to release an 8TB 870 QVO.

The 870 QVO is a standard 2.5in SATA 6GB/s SSD. It's available in 1TB, 2TB, 4TB and the aforementioned 8TB capacities. It uses Samsung's own MKX controller. The 1TB 870 QVO features a 1GB DRAM buffer, going up to 2GB for the 2TB version and so on. Samsung includes 256-bit AES hardware-based encryption support. The 1TB 870 QVO has an endurance rating of 360TBW, which is decent for a QLC drive. We'd like to see a five year warranty instead of the three year warranty that's offered. This alone could steer users towards competing TLC drives with five year warranties.

870 QVO drives come equipped with SLC cache. This provides fast burst performance, however the 1TB 870 comes with a 42GB cache, whereas all the other 870 QVOs come with 78GB. This means the 1TB drive will run into a performance cliff faster than the higher capacity drives. This is exacerbated by Samsung's own claim of 80MB/s sequential writes post cache saturation compared to 150MB/s for the higher capacity drives. If you're after performance, you're better off with an alternative drive, but remember that performance is not the major selling point of this drive. If you're using it for bulk storage, write performance is a minor consideration.

SPECS
Samsung 870 QVO 1TB 2.5in SATA 6GB/s SSD, Samsung MKX Controller, Samsung 4-bit MLC V-NAND, 560MB/s sustained read, 530MB/s sustained write, 98K/88K read/write IOPS, AES-256 hardware encryption, 360TBW endurance, three year warranty.

The 1TB 870 QVO provides acceptable performance, but don't expect to rewrite the record books. If you don't thrash it with writes, it will obliterate a mechanical HDD thanks to the inherent latency and I/O advantages of an SSD. This is what makes a drive 'feel' fast.

So, with SATA SSDs becoming commodity items, pricing is arguably the biggest differentiating factor, and this is where the 870 QVO currently falls flat. At $195 at the time of writing, it's priced well above several competing TLC drives. Is it to do with Covid-19 logistical headaches? Or just early adopter pricing? Drop it to $150 and we'd evaluate it in a whole new light, which honestly should happen in time. At $195 though, it's hard to recommend the 1TB 870 QVO. We are really excited to see the 8TB drive coming soon. SSD pricing continues to evolve so keep an eye out for 870 QVO bargains in the coming months.

CHRIS SZEWCZYK

The Samsung 870 QVO advances QLC tech, but it needs a serious price drop in the face of stiff competition.

★★★½☆

	Crystal Disk Mark				AS-SSD
	Read MB/s		Write MB/s		
On test / Indicates best result	Seq	Random 4k	Seq	Random 4k	Score
Samsung 860 EVO 1TB	562.3	44.3	531.2	163.2	1,249
Samsung 870 QVO 1TB	561.3	42.4	509.5	137.2	1,089
Crucial MX500 1TB	563.2	46.7	516.7	151.9	1,201

$269 | www.hyperxgaming.com

HyperX Cloud Alpha S

High-end headset, high-end sound.

Finding a high-end gaming headset that strikes a balance between PC and console gaming compatibility can be tricky. Connectivity and compatibility are top priority, and a lot of premium headsets are made to be used with just one type of console or only PCs. However, the HyperX Cloud Alpha S is designed for gamers who are just as comfortable on the couch as they are in a gaming chair. The robust build and multiple connection options make it an excellent choice for anyone looking to invest in a quality, high-priced headset that will last for years. Each ear cup is built with dual chamber drivers that separate bass notes from mid and high range sounds for enhanced audio distinction. They also have bass adjustment sliders which let you select three different levels of bass for each ear for custom equalisation.

The headset uses a 7.1 channel virtual surround sound mixer that is built into the connection lines to give you deep, rich audio, and the ability to pinpoint sound cues. You can activate the surround sound or turn it off with the push of a button.

We tested the headset with *The Last of Us Remastered* on PS4 and were quickly reminded of how terrifying a zombie apocalypse should be. The over-ear design of the ear cups do a decent job of blocking out ambient sound so we can focus entirely on in-game audio, though very loud noises can be heard over gunfire and in-game music.
TAYLOR CLEMONS

The HyperX Cloud Alpha S is an excellent headset for both PC gaming and with the Xbox One X. If you mainly use a PS4 or Nintendo Switch, you'll still get great audio, but you won't be able to take advantage of the 7.1 CH virtual surround sound.
★★★★★

$109 | tp-link.com

TP Link Archer TX3000E

Bringing Wi-Fi 6 to where it's needed most.

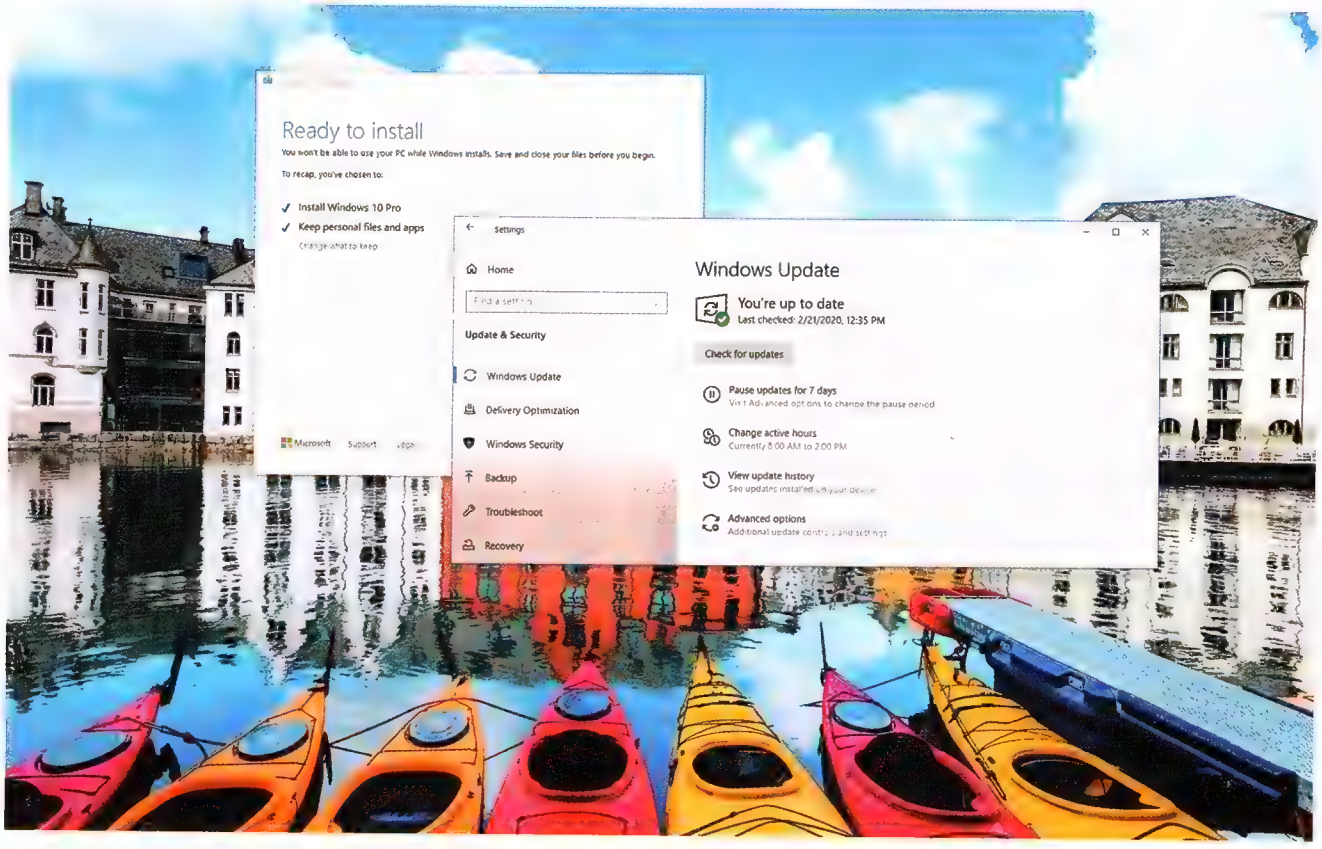
I recently rearranged my home to better suit perma-WFH needs, and the ideal new spot for my PC desk meant an Ethernet cable would have to worm its way unattractively across a big room. It was clearly time to go wireless! With a Netgear Nighthawk AX8 Wi-Fi 6 router already in place, I picked up the Wi-Fi 6 TX3000E PCIe adaptor from TP-Link to do the job.

Going into a PCIe 1x slot, the card is covered by a good looking red heatsink to cool Intel's AX200 Wi-Fi 6 chip. It also supports Bluetooth version 5, and comes with a cable to connect to your motherboard header, should you wish to use this feature. A twin-antenna unit with a generous 1m cable attaches via gold-plated plugs, and that has a very strong magnetic base that gives you good placement options. The latest TP Link drivers were installed, and it connected immediately.

At a distance (unobstructed) from the router of around 12m performance should be excellent – and it was, netting exactly the same speeds as I saw previously via Ethernet. My NBN is the limiting factor, though. The card's theoretical maximum is 2402Mbps on the 5GHz band, and 574 on 2.4Ghz, so, plenty of headroom!

In a month's use it's never dropped out, streaming 4k video is flawless and sub-10ms gaming is lovely to have. If you have a Wi-Fi 6 router this does a great job of connecting a PC – I'm planning on getting a second for the spare room racing rig PC too, and saying goodbye to blue cables forever.
BEN MANSILL

Simple to install, flawless in operation, add your PC to a Wi-Fi 6 network without compromise.
★★★★½



Free | support.microsoft.com/en-au

Windows 10 May 2020 Update

More secure, reliable and efficient than ever before.

The first major Windows 10 update that Microsoft has rolled out in 2020 brings in a whole new set of features and performance refinements to the versatile OS. Improvements abound with this update, from better security and sign-in experience to an updated chat-based user interface on Cortana, with Microsoft focusing "on meeting the over a billion people around the world relying on Windows where they are now."

Here are some of the major refinements the Windows 10 May 2020 Update delivered:

Faster Windows Search

The Start menu search has been causing performance issues due to excessive disk and CPU usage. However, with the Windows 10 May 2020 Update, Microsoft has rolled out a fix that's now detecting peak usage times to better optimise the Windows search indexer.

Cortana chat-based experience

With the Windows 10 May 2020 Update, Microsoft is also rolling out a new chat-based experience with Cortana. With this feature, you now have the option to speak or type your questions to Cortana. Your conversation history will appear in a chat window, which you can resize, move around on your desktop and switch to dark mode.

Potentially unwanted apps blocking

You'll now have a way to block potentially unwanted apps (PUA) that might have undesirable advertising, use your PC for cryptomining or do other things on your computer. With this new update, the OS can now detect such apps and notify you so you can make an informed decision on whether or not to download them.

"Improvements abound with this update, from better security and sign-in experience to an updated chat-based user interface on Cortana, with Microsoft focusing "on meeting the over a billion people around the world relying on Windows where they are now." "

Microsoft Edge memory improvements

Microsoft Edge will be the one of the first Win32 applications to take advantage of segment heap capabilities, which delivers a memory usage reduction of up to 27%. This lower memory usage when browsing on Microsoft Edge will help offer a better device experience, as more memory will be freed up for other applications.

New Notepad features

Text editor Notepad gets quite new features with the Windows 10 May 2020 Update. Those features include quick text zooming, wrap around find/replace, and an asterisk in the title bar to remind you to save the document.

Go passwordless

PINs or Windows Hello biometric sign-ins are much more convenient methods of logging in to your computer. And with the Windows 10 May 2020 Update, you can go completely passwordless. There's a new "Make your device passwordless" option in the Settings so you can forgo passwords altogether.

MACOS X 10.10 or later | Free/in-app purchases | aptonic.com

Dropzone 4

A fast, efficient tool for moving files and launching apps.

One of the most popular categories on the Mac App Store is 'launcher' programs that provide new ways of quickly launching apps, or moving files and folders around. Dropzone from Aptonic has always been a popular choice here, and was recently updated to version 4.0. This new version provides a basic set of features for free, or you can pay a subscription of $1.99 per month to unlock the Pro version that has a number of additional features. Oddly, version 3 is still available too (note that there's also an app called DropZone 2 as well – with a capital 'Z' – but that's from a completely different developer).

When you install Dropzone 4, it adds an icon to the menu bar on the top right of your screen. Clicking on this opens a menu for using Dropzone, or you can simply drag a file or app up towards the menu bar to display a much larger icon that acts as a 'dropzone' that activates the app more quickly.

The Dropzone menu is divided into three rows, starting with the Drop Bar at the top. Placing a file in here creates a kind of alias so that you can quickly open the file or move it to another location when you need to. The next row is the Grid, and this allows you to store both apps and folders, so that you can quickly launch apps, or move or copy files from one folder to another. The third row contains more complex 'actions' – such as using AirDrop to transfer files to another Mac, or using the Tiny URL service to quickly create short versions of web links.

Dropzone's menu lets you store files, folders and apps, and quickly open them, copy them, or move them around.

This large icon is the 'dropzone' where you can quickly drag-and-drop your files.

Subscription option

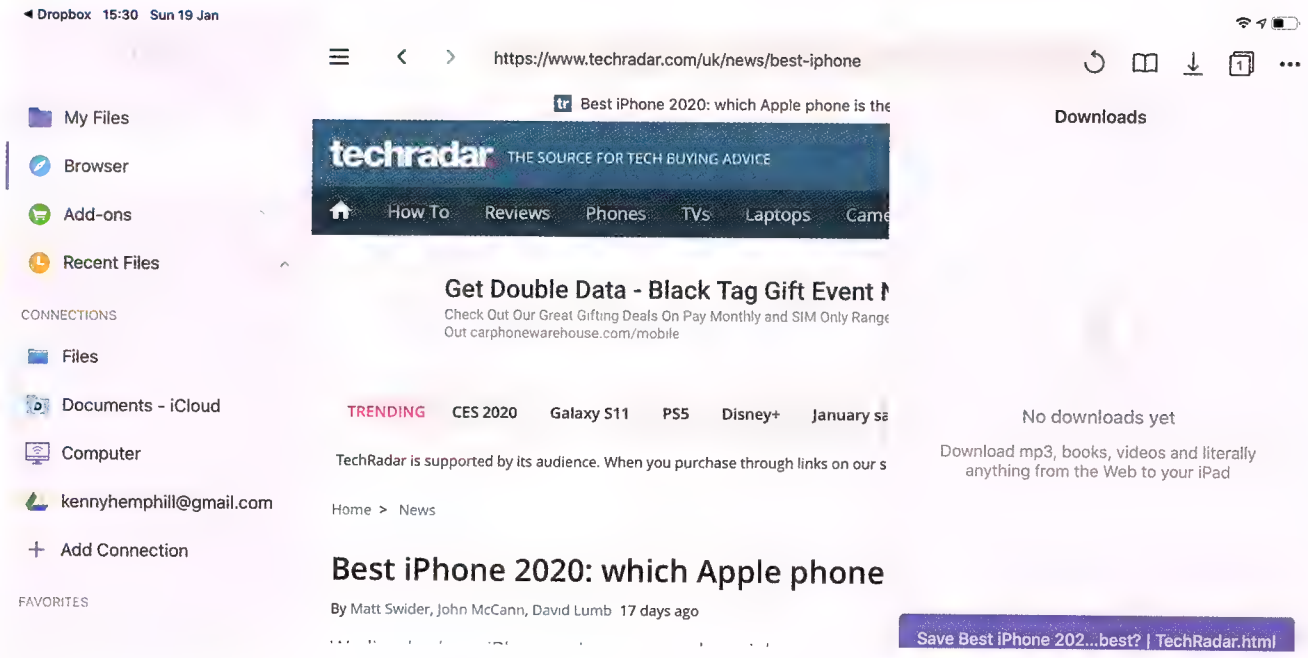
We're pleased to see that all these features are free, and you only need to pay the subscription fee if you want to use more advanced features such as keyboard shortcuts for launching apps and actions. The subscription also gives you free upgrades in the future, as well as access to a larger library of actions for tasks such as uploading files to Google Drive, downloading videos from YouTube, or using text-to-speech.

That's a bit of a bargain, as many people will find the free version of Dropzone really useful all by itself. And if the Pro version includes a particular feature that you need then the modest subscription fee will soon pay for itself by saving you time every day.

CLIFF JOSEPH

A quick and easy way to access and control your files, folders and apps.

★★★★★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Best iPhone 2020: which Apple phone is the
My Files
Browser
Add-ons
Recent Files
CONNECTIONS
Files
Documents - iCloud
Computer
kennyhemphill@gmail.com
Add Connection
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techradar THE SOURCE FOR TECH BUYING ADVICE
How To Reviews Phones TVs Laptops
Get Double Data - Black Tag Gift Event
Check Out Our Great Gifting Deals On Pay Monthly and SIM Only Range
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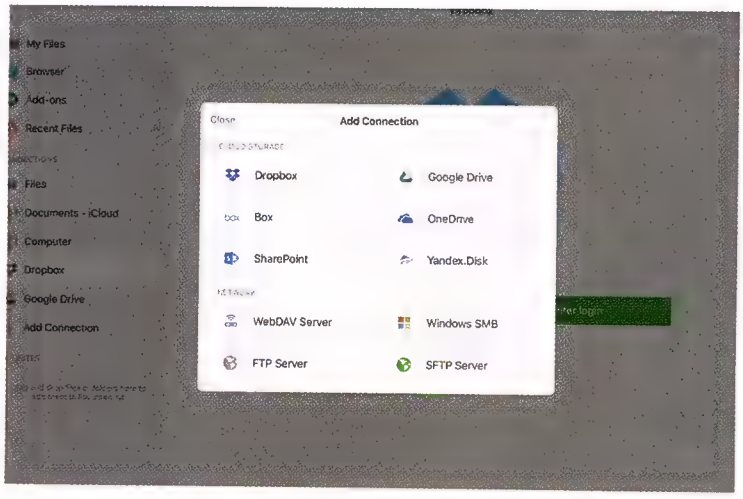
Documents 7

iOS Files app not enough? Try this...

Documents began life as a handy way to share files between apps on an iPhone or iPad. A decade or so later, it's evolved into a lot more than that and offers quite a bit more than Apple's own Files app, so it's worth checking out.

New in version 7 are an improved web browser that supports private browsing, integration with the Files app so you can open files from Apple's app in Documents, a dark mode, and the ability to mark up images and annotate PDFs. Also new is a big '+' button at the bottom right of the screen. Tap it and you can create a new folder, text file, or PDF. Or you can import photos from the Photos app, files from Files, or transfer files from a Mac or PC using Documents' Wi-Fi Transfer tool. The '+' button also lets you add cloud storage services like Google Drive and Dropbox to Documents. The app can also connect to SFTP, SMB, WebDAV, and even SharePoint.

"You can also watch movies, listen to music, and view photos, as well as open ZIP files and view Word and Excel documents."



Documents allows you to access files on several different services, including Microsoft Sharepoint.

Version 7 features an improved web browser with private browsing and the ability to download files.

apc RECOMMENDS

Media options

You can also watch movies, listen to music, and view photos, as well as open ZIP files and view Word and Excel documents. Files can be tagged and marked as favourites. But tag support is limited to colours – you can't create your own named tags. And we couldn't actually find any way to view all the files tagged with a colour. Our only other minor criticism is that while the Files app (which opens inside Documents) and Photos albums are available from the main screen, to see files stored on a cloud service or server, you need to tap Connections then the name of the service. We would like to be able to add them to the main screen.

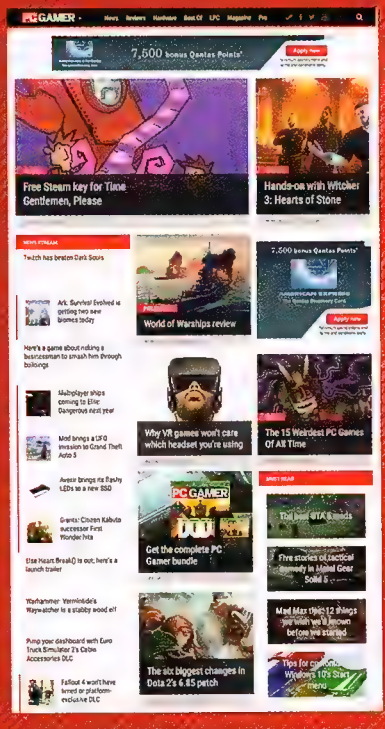
Other than that, it works very well. The web browser with its ability to download files is great, as is Wi-Fi Transfer. The new '+' button makes creating folders and importing files easy. It's free, but if you want to sign or edit PDFs from within the app, you'll need the US$49.99 in-app purchase.

KENNY HEMPHILL

Offers the ability to share files with PC users and download them from the web.

★★★★☆

SMARTER COOKIES ENABLED


PCGAMER
7,500 bonus Qantas Points*
Apply now
Free Steam key for Time Gentlemen, Please
Hands-on with Witcher 3: Hearts of Stone
World of Warships review
Why VR games won't care which headset you're using
The 15 Weirdest PC Games Of All Time
Get the complete PC Gamer bundle
The six biggest changes in Dota 2's 6.85 patch

JOIN US ONLINE AT
WWW.PCGAMER.COM

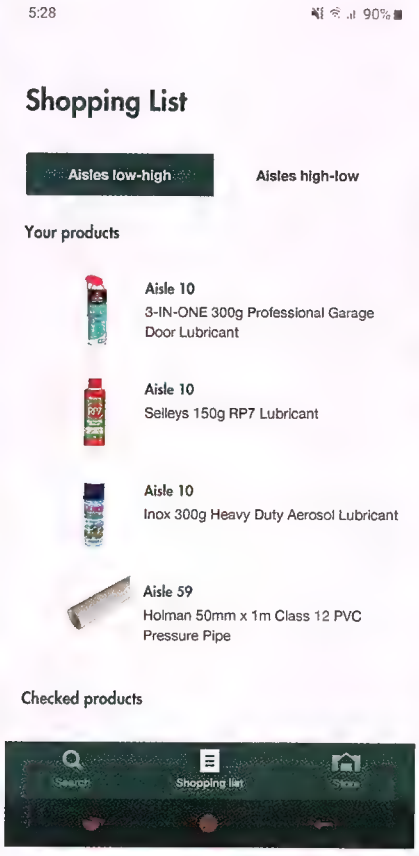
Android | Free

xbStream Controller for Xbox One

Games are for everyone.

We love a free app that gives people accessibility options into gaming. xbStream allows you to use your phone as an Xbox One controller by pairing directly with your console. This is pretty cool in itself but it also lets you fine tune the settings and move buttons around. If you have troubles using a regular controller due to injuries, different ability levels, disabilities, or any other reasons, this could be a game changer. Lots of kids play tonnes of games on their phone and might prefer the option of the familiar on screen controller. I'm not one of them. I love a good physical controller, but I did test it out. For games, as long as they're simple, it was perfectly fine for me. Plus, there's a level of convenience to not having to find a controller just to check a setting. Sometimes it can be a little slow on dis/connection but other than that it's a solid little app.

★★★☆☆



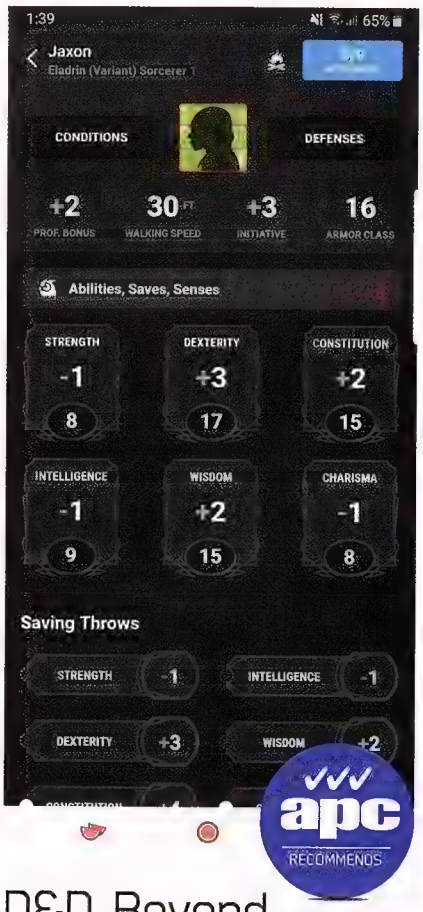
Android | Free

Bunnings Product Finder

Product sorter.

I'm sure I'm not the only one who has seen their new COVID-supplied stay at home life-style give them cause to look a bit harder at their home. For me, this has meant multiple trips to Bunnings and often for weirdly specific things. I've learnt that the Bunnings website is very hit and miss when it comes to searches, so I was curious about the app. Sadly, the app isn't any better and appears to use the same search. However, it found a few other ways to impress me. It picked my closest correct store by location, which the website has never managed. It also has a shopping list where you can add products at the click of a button. You can sort this by aisle and there's even a little map showing you were the aisles should be. It didn't fix the problem I wanted it to, but it still offers a good level of functionality for the Bunnings addict in your life.

★★★☆☆



D&D Beyond Player Tools - mobile character sheets

I'm very normal.

Android | Free

Roleplaying games can provide temporary relief and Dungeons and Dragons is one of the most popular. If you're feeling daunted about jumping in, character sheet tools like this are incredibly helpful and there's a lot to like about this one. It essentially pulls the official toolset website into an app. The first page gives you the options to make a quick simple character, a random one, or total customisation. The latter is actually pretty intense and gives you heaps of information to help you build a character. There's even consideration to restrict the sources and rules your campaign uses. But even if you aren't big on playing games there might still be something here for you. Character creation tools are great to help plot out ideas for writers. Reading about the worlds and different races is equally fascinating without ever rolling a die. You could even base characters of your family and pit them against each other.

★★★★☆

HOPE CORRIGAN

DXT2 1.2

Unable to control his fetish for tinkering with new distros, at long last Mayank Sharma finds himself a newcomer that isn't half bad...

The Windows 7 EOL was too good a hook to miss out on and now there are several new distros that promise to offer a suitable replacement for the popular-but-defunct proprietary OS. The awkwardly-named DXT2 is another addition to this growing list and came about because its developer wasn't satisfied by any of the existing desktop distros. The main pull of the Debian 10-based distro is its rendition of the Xfce v4.12 desktop environment that's been heavily customised to give users a lighter and user-friendly experience.

Two of the more noticeable differences in DXT2's Xfce4 desktop are the Tint2 panel and the Pmenu applications menu, which are used by default in place of the official Xfce components. The lightweight elements have been tweaked to blend with the other components of the desktop, which have also been modified to match the distro's minimalistic approach. For instance, the menu is one of the noticeable elements that's been taken from the Thunar file manager.

Talking of the file manager, the developer has also appended some useful custom actions in the right-click context menu. You can, for example, open the current folder inside a root terminal in addition to a normal terminal. Similarly, you can also edit any file as the root user as well. If you work with images, there's an option to convert any image file to JPG at the click of a button.

DXT2 has separate Live and installation mediums. The installation medium defaults to the graphical Debian installer and the developers haven't bothered to delete references to Debian 10, which is a good thing since they've prioritised execution of their ideas to the desktop experience over cosmetic changes to the installer. If you can earmark the entire disk to the distro, you can use the installation script on the Live medium to anchor the distro to your disk as well.

Down to the bone

DXT2 is designed to be used as a light base to act as a foundation to build your installation. The distro ships with barely any programs and while it uses the standard Debian Buster repositories, DXT2 doesn't even ship with a package manager.

To flesh out the distro, you can use the custom installation scripts that reside inside the /usr/share/dxt2 directory. The current release has scripts to install Google Chrome, LibreOffice, Sublime Text, TeamViewer, VirtualBox as well as Samba and CUPS. These will work best for new Linux users. Experienced campaigners can use `apt` from the CLI or install the Synaptic package manager if they prefer using a graphical interface.

In addition to the installation scripts, the distribution has some scripts for some system administration tasks as well. If you're using the distro on a computer with lots of RAM, there's a script that will activate the tmpfs filesystem for speedier file accesses. If you've installed DXT2 on a SSD, there's a script that will set up a weekly TRIM cron job and also set the scheduler to deadline to improve performance.

When you've finished setting up your desktop as per your requirements, you can use the exportiso script to dump all the customisations into a Live ISO image. The image mirrors your installation in that it contains all the applications that you've added to your DXT2 installation as well as all the files you've created. This makes it one of easiest distros to transform your installation into a portable environment.

For a project in its infancy that still lacks documentation and doesn't have a real support infrastructure, DXT2 has taken impressive first steps towards becoming a very capable light distro.

MAYANK SHARMA

Ignore its young age and the peculiarities that come with it, and you have yourself a capable, light Debian-based distro.

★★★☆☆

"The current release has scripts to install Google Chrome, LibreOffice, Sublime Text, TeamViewer, VirtualBox as well as Samba and CUPS. These will work best for new Linux users"

The developer of DXT2 works at a school and has crafted a special edition of the distro to suit his workplace.

insert
delete
backspace
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ULTRABOOKS & 2-IN-1s FOR GETTING THINGS DONE

Joel Burgess collected the best professional laptops and 2-in-1s of 2020 and let them fight it out for the laptop crown. Can one machine do it all, and can a good pro laptop also handle some gaming?

While we don't have anything like the launch of the first OLED laptops to really distinguish 2020 laptops from their predecessors, there are a number of smaller advancements that do add up to a good amount of new tech in this year's updates. The second generation of AMD processors are showing some serious headway in raw computing power and overall efficiency – even if Intel is still ahead when it comes to laptop gaming capabilities. Of course Intel has also updated to 10th Generation CPUs, which bring with them the new Wi-Fi 6 networking specification and often some interesting features like the Project Athena certification.

Perhaps more importantly though, we're now into the second generation of Core i9 laptops, and while these overclockable 9th generation processors ran a little too hot for most host devices, they seem to have become more balanced this time round and deliver harnessable performance bumps.

If that wasn't enough you'll also see the arrival of a handful of units with 300Hz monitors this year, which perhaps isn't critical for professional ultrabooks, but is a boon for anyone who likes to do some high level gaming when they clock off.

Devices continue to make incremental reductions to overall size, meaning there's offerings here under a centimeter thick and clamshells that weigh less than a kilogram, which is a pretty neat milestone.

The same steps are being made in processor efficiency and battery technology so that you can now get powerful laptops with full-day battery life.

It's not even too farfetched to expect your work rig to be able to do heavy graphical work loads and carry light gaming capabilities.

Not a bad time to buy a professional laptop on the whole!

From $1,799 | acer.com

Acer Swift 5

Is Acer trying to pull a quick one with its new professional ultrabook?

The Swift 5 is one of the few offerings here that range an Intel Core i5 model as well as the more powerful i7-1065G7 variation, so you can get one for as little as $1,799. For that you'll get the i5-1035G1, 8GB of RAM and a tiny 256GB SSD, which is just enough to be able to work from if you have everything in the cloud. If you can afford the $2,399 model you'll get that faster processor, 16GB of RAM and a serviceable 512GB of PCIe SSD storage, which is a more well-rounded configuration.

Like Asus's ExpertBook, the Swift 5 is trying to be as light as possible at just 990g, although while the former manages to keep everything feeling premium in the process, the lack of resistance on the Swift 5's thin plastic keyboard and trackpad can feel a little flimsy and loose for a premium ultrabook. That said, it was perfectly workable, and without another laptop to compare next to it you probably wouldn't notice the difference that much. The 1080p IPS screen doesn't look particularly enticing next to the other devices here, but it is enough to still look nice and is capable of decent media playback.

Performance was between three and seven percent above the average quad-core CPU on PCMark 8 and 10 benchmarks, but was between three and fifteen percent behind on raw CPU and media encoding tests. It was also forty percent behind the average GPU performance, only beating the Spectre x360 and the ExpertBook, but it did have decent battery life, lasting seven hours and 32 minutes in 1080p movie playback.

A long-lasting and lightweight professional ultrabook that's powerful enough for those on a tight budget.
★★★★☆

From $1,599 | apple.com/au

Apple MacBook Air 2020

Is the design of Apple's recent entry level laptop air-tight?

The MacBook Air range is back and it's trying to fill the space Apple recently made when it discontinued the 12-inch MacBook in 2019, as well as be a good upgrade. What is nice is that Apple has managed to reduce the base price of the 2020 MacBook Air by $100, so you can get a configuration with a 1.1-3.2GHz dual-core Intel Core i3 CPU, 8GB of RAM and 256GB of storage for $1,599. If you are doing any more than the lightest of web browsing and document processing you'll probably want to go for the 1.1-3.5GHz quad-core Intel Core i5 CPU, 8GB RAM and 512GB storage configuration for $1,999. This is the first quad core processor on a MacBook Air, so the performance bump will be dramatically larger than that of previous generations. If you do want to bolster performance even further then you can upgrade the CPU to a 1.2-3.8GHz quad-core Intel Core i7 CPU for an extra $150, or double the RAM for $300 more and then there are also two additional storage options of 1TB and 2TB, which cost an additional $300 and $900 respectively.

We got our hands on the standard Core i5 variation, which was about 20% behind the average quad-core devices here on the Geekbench 4 multi-threaded CPU test. This is about five to 10 percent lower than we were anticipating, but it's still more than enough to get you by if you have light browser based workloads.

Battery life is seven hours and 55 minutes for 1080p movie playback, which means you'll just get through a work day under light usage.

A great lightweight work device for those wanting MacOS on a tight budget.
★★★★☆

"We got our hands on the standard Core i5 variation which was about 20 percent behind the average quad-core devices here on the Geekbench 4 multi-threaded CPU test."

From $3,799 | apple.com/au

Apple Macbook Pro 16

Nothing beats the big Apple.

Apple's new Pro form factor is only 2% bigger than the MacBook Pro 15 in chassis size, but offers an inch more screen thanks to a better screen to body ratio. It's also got a bigger heat sink that is capable of handling the powerful CPUs that range all the way up to an Intel Core i9-9880H CPU. Apple is the only vendor here to have 9th generation CPUs in its current lineup, since Intel wasn't doing a great job at delivering the custom processors in a timely fashion (which is likely why Apple announced in June that it'd be making its own chips going forward). Nevertheless the processor's optimisation in the MacBook Pro 16 is one of the best we've seen and more than holds up against Intel's stock 10th-generation mobile CPUs.

The 3,072 by 1,920 pixel Retina display is one of the standout features, with a bright 500nit HDR display capable of reproducing the full P3 gamut, which is critical for videographers.

If you do need extra graphical processing capabilities then the MacBook Pro 16s can be configured with an AMD Radeon Pro 5500M GPU that is competent at graphical processing and will even offer decent 1080p gaming performance.

While this premium unit isn't cheap in any configuration, some of the higher specced units are actually competitively priced and Apple has made some solid design choices by reinstating the Magic Keyboard design, including powerful Dolby Atmos configured speakers and throwing in a 100Wh battery that'll keep you going for 11 hours of web browsing.

An powerful laptop for video editors and creatives that want access to Apple's software.

★★★★½

$3,199 | asus.com/au/

Asus ExpertBook

Asus is championing the benefits of Project Athena.

There are other laptops in this roundup using the Intel Core i7-10501U CPU, but we didn't really see this chip's potential till we came to the ExpertBook. You see, the base clock sits at 1.8GHz, but the quad-core i7 can boost to a speedy 4.9GHz, which means that while it has the power to perform demanding tasks, it can also be super efficient. Asus has taken this feature and run with it in the Expertbook, adding a 66Wh Li-Po battery to give it serious longevity. While the 24 hour lifespan claimed in its marketing material is a little lofty, we did get seven hours and 30 minutes in PCMark 8's battery life benchmark, which we're guessing could last 12 or so hours under light work conditions. This is the best offering of the roundup by about an hour (and is only outlasted by the 15-inch Surface Laptop 3 according to our records), which is a great feature on an ultraportable work laptop. Despite being more efficient, when it comes to general work tasks and RAW CPU performance the ExpertBook actually outperformed most quad-core processors here. There is a bit of a sacrifice in terms of graphical performance, netting between half and a third of the devices with the Intel Iris Plus Graphics.

The ExpertBook is wrapped in a magnesium lithium alloy that is lighter than aluminium and allows the device to come in at an impressive total weight of 995g. The 14-inch 1080p frameless NanoEdge display has a nice 94% screen-to-body ratio and the device takes the screen's 16:9 footprint.

A powerful compact ultrabook that'll last as long as you do.

★★★★½

From $2,199 | asus.com

Asus ROG Zephyrus G14

AMD's new CPU makes the G14 powerful, efficient and reasonably priced, so what's the catch?

The Zephyrus G14 was the first device we've tested with one of AMD's second generation mobile processors, the Ryzen 9 4900HS, and it's a big win for both AMD and Asus. Against MSI's GS66 running a hexa-core Core i7-10750H, the G14's 8-core 4900HS offered between five and eleven percent more power in raw multi-threaded computing tasks. It even kept pace with a MacBook Pro 16 running an i9-9880H in the Geekbench 4 Multi-core benchmark, which is an amazing result considering this configuration of the G14 is $2,799 and the i9 MacBook Pro 16 starts at $4,399.

It doesn't skimp on the graphical capabilities either, with this unit offering 16GB of RAM and an Nvidia RTX 2060 GPU, which means it's capable of solid 1080p gaming (30fps+ on Ultra), and heavy graphical workloads. This is handy considering it can be configured with a high refresh rate 120Hz 1080p screen, although we'd recommend opting for the 60Hz WQHD 1440p display if you're using it for work as it makes reading detailed documents easier.

Despite being supremely powerful the Ryzen 9 is extremely efficient, offering eight hours and 24 minutes of 1080p movie playback, which can be stretched to over 12 hours by manually swapping the display to 60Hz and turning the discrete GPU off in power settings.

There are some peculiarities like the lack of a webcam, lightweight plastic chassis and a mushy keyboard, but these elements allow it to be just 1.8cm thick and 1.6kg, so they're not exactly deal breakers.

A standout performer with amazing battery life, and solid graphical capabilities.

★★★★★

From $2,799 | dell.com/en-au

Dell XPS 13

Dell's 2020 professional ultrabook might not be as good as expected.

The XPS range is considered by many to have been the class-leading ultrabook for years running now due to its Infinity Edge display, decent battery life and good balance of professional level components. This year's XPS 13 builds on these strong points with a new 13.4-inch 500nit 4K display with such thin bezels that allow it to fit into a traditional 11-inch chassis form factor. You can choose from a 10th Gen Intel Core i5 or i7 CPU catering to your pricing and performance needs and this is complimented by either 8GB or 16GB of RAM and various PCIe SSD sizes.

The new CPU offers a five percent performance bump over its predecessors and landed somewhere in the middle of the laptops tested here in overall computing performance (even though raw CPU performance was the highest scoring quad core chip). GPU performance was about what you'd expect from the Intel Iris Plus Graphics, capable of handling browser-based gaming and essential graphical tasks easily enough.

At 1.5cm thick and just 1.27kg the XPS 13 is one of the most portable models here, but battery life is a little disappointing at just five hours and 50 minutes in 1080p movie playback. This means you won't get a full day of working out of it without seriously tweaking brightness and power settings. Stack it up next to the other devices here and you'll also notice it comes with a premium price tag, despite only offering quad-core CPU performance.

A decent ultraportable that is a little overpriced and under-specced to be the laptop to beat anymore.

★★★★☆

From $3,699 | dell.com/en-au

Dell XPS 15

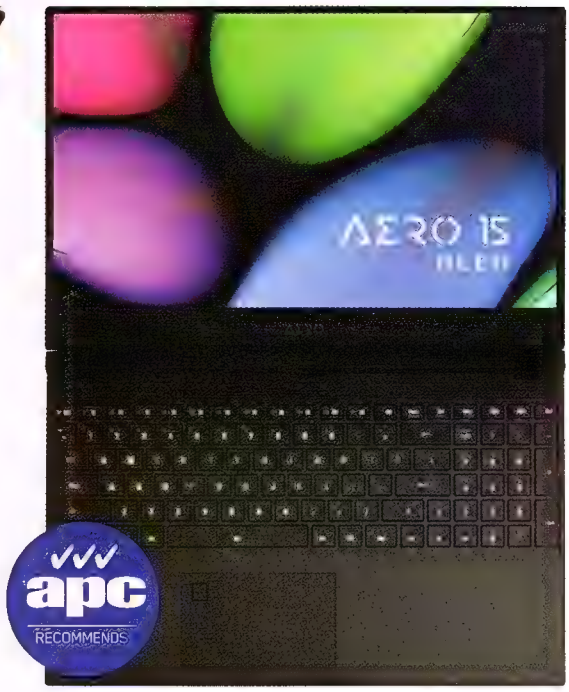
Dell's flagship 15-incher re-focuses on performance.

While we were disappointed to see that Dell dropped the OLED panel option on its 2020 XPS 15, the new unit's screen specs are still respectable. At the top end it can be configured with a 4K 500nit HDR screen that's capable of Dolby Vision and reproducing 100% of the Adobe RGB colour gamut, or you can opt for the FullHD panel and save $600. Dell has also ditched the throttled Core i9 model, offering only a hexa-core Intel Core i7-10750H or a octa-core i7-10875H CPU. This means that the XPS 15 really only varies on FullHD/4K screen resolution, storage and RAM allocation.

The 6-core models all feature 16GB of RAM and start at $3,699 for a 1080p screen and 512GB of storage. This pricing lines up pretty closely to Apple's MacBook Pro offering, but the XPS 15 was one of the few devices we tested this year with a hexa-core CPU since most of the laptops were either four or eight core chips, which made it a little hard to compare. Interestingly the XPS 15 actually beat the supposedly more powerful 8-core i7-10875H CPU on a Blade 15 (Advanced) from Razer by between 2% and 19% in all raw CPU benchmarks, even though it fell up to 30% behind in general working tasks. Battery life was less than ideal with the unit only lasting five hours and 49 minutes in 1080p movie playback and while the GPU is good for light 1080p gaming and moderate graphical workloads, it's not really the same as some of the more powerful gaming rigs on offer here.

A powerful professional laptop that ticks all the boxes but doesn't do much to distinguish itself in a competitive space.
★★★★☆

"Dell has also ditched the throttled Core i9 model, offering only a hexa-core Intel Core i7-10750H or a octa-core i7-10875H CPU."



$3,499 | gigabyte.com/au

Gigabyte Aero 15 OLED

The amazing colours of OLED shine through in Gigabyte's latest professional powerhouse.

With a 4K VESA certified HDR OLED panel at 400nits up front, it's hard not to be wooed by Gigabyte's Aero 15 OLED. Supporting this premium screen is one of three Intel Core processors, the hexa-core i7-10750H, the octa-core i7-10875H and the octa-core i9-10980HK, which are three of the most powerful laptop processors around. RAM ranges from 16GB to 64GB and you can configure it with any Nvidia GPU between the RTX 2060 to the RTX 2080 Super locally. This ultra premium range starts at $3,499 so it's really only for those with the heaviest workstation requirements. Unfortunately this unit doesn't perform quite as well as it should, lining up with Apple's Core i9 MacBook Pro 16 on Cinebench R20 benchmarks and scoring 15 percent lower than the hexa-core+ average in the roundup on PCMark 8 benchmarks. It's also a little more expensive than it needs to be considering the $5,699 unit we tested only offered 512GB of storage space, but at least some of this is going to be down to the OLED display.

The Aero 15 OLED also has a decent 94Wh battery that lasts 4 hours and 41 minutes in PCMark 8 benchmarks and 6 hours and 10 minutes in 1080p movie playback, even with the extremely powerful components and 4K display.

Graphically this machine is really solid with the 2080 Super landing in between the similarly specced MSI GS66 and the Razer Blade 15. The unit manages to come in at under 2cm thick and weighs less than 2kg, so gone are the days when power translated to a lack of portability.

A powerhouse ultrabook with an amazing screen and long lifespan that's pricey and a bit light on storage.
★★★★☆

From $1,479 | hp.com/au

HP Spectre X360

This compact 16 by 9 ultrabook is undeniably a spectacle.

The Spectre x360 is HP's long standing ultrabook convertible, pitched at professionals who want all the pro-perks in a 13-inch foldable form factor. The convertible features a new 13.3-inch 4K AMOLED touchscreen that can produce deeper blacks and a much more vibrant picture. The Spectre X360's OLED panel looks amazing during media playback and the screen has a Delta E colour variation of less than two, so you'll be able to use the included Adobe RGB and DCI-P3 colour profiles for HDR colour work on the go.

The Spectre x360 comes with either an Intel Core i5-1035G4 or an Intel Core i7-1065G7 CPU that range in price from $1,497 to $3,799. While the former is generally paired with 8GB of RAM and a 256GB SSD, the i7 features either 8GB or 16GB of RAM and 512GB of SSD storage, depending on the retailer you're shopping at. The Core i5 Spectre x360s is limited to a Full HD 400nit IPS panel, while the Core i7 models can choose between 1080p or 4K OLED displays. The i7 models also come with an additional 32GB of Intel Optane Memory which is designed to speed up overall system responsiveness by adding a cache of fast short-term memory to the systems that need it.

Battery life is a little underwhelming at four hours and 40 minutes in 1080p movie playback, so you'll need to take your charger for a full day of work.

A sleek 13-inch OLED touchscreen convertible with a solid processor, business perks and a slightly undercooked battery lifespan.

★★★★☆

$3,299 | consumer.huawei.com/au

Huawei Matebook X Pro

The 2020 update of this early success is really testing the friendship.

Not many vendors are able to hit a home run on the first swing in a new region, but Huawei's first 2018 Matebook Pro got very close, so we had high expectations from the 2020 update. The new MateBook X Pro again borrows its general aesthetic and naming style from Apple, but it offers some unique features and a low enough price, for it to seem nit-picky to focus too much on this. The 2020 MateBook X Pro has a 13.9-inch 3000 x 2000 pixel resolution display and the same 91 percent screen to body ratio as its predecessor, but instead of offering two configurations, there's just the one more powerful offering this time around. This is made up of an Intel Core i7-10510U quad-core CPU, 16GB of RAM and a Nvidia GeForce MX250 GPU, which is a great configuration for a professional work machine. CPU performance was generally between 10% and 20% below the average of the quad-core performance on multi-threaded and general work tasks and the GPU was at most 20 percent better with the discrete GPU being entirely pointless at times. This disappointing performance is compounded by the new device's price hike, which makes it far less competitive than the 2018 offering. While 1080p media playback battery life is 10 hours and 37 minutes, PC Mark 8 battery life is just three hours and nine minutes, so your mileage will vary depending on how heavy your workload is. While this isn't a complete fall from grace, this device has made enough critical missteps to mean that it is no longer a contender for the best laptop crown.

Sub-par performance and a price hike mean that this decent device isn't looking like a segment leader anymore.

★★★½☆

$3,699 | lenovo.com/au

Lenovo Yoga C940

You'll pay a bit of a premium for Lenovo's flexible flagship this year.

Lenovo's flagship Yoga 2 in 1 has long been at the top of our favourite 2-in-1s list and the C940 looks like it'll be tough to beat again this year. While the 14-inch 4K model with a Vesa400 HDR certification was originally being sold at Bine Lee for $2,999, this model seems to only be available directly from Lenovo for $3,699 now... which is a little disappointing. Nevertheless, the Yoga C940 is sporting one of Intel's latest 10th generation 10nm Ice Lake CPUs that brings Wi-Fi 6, better AI processing and a new GPU to the range. The Yoga C940 was between five and 21% better than the Yoga C930 in all our CPU and general performance benchmarks, averaging out to around 10% across most tasks. If we put the Yoga C940 against the Surface Pro 7 with the same i7 CPU and 16GB of RAM the two largely perform at a similar level.

One thing that was worth noting is that the Yoga runs hot, with the optimised CPU regularly hitting 100-degrees. We would usually say that pushing a CPU this hard would reduce the battery lifespan, but the C940 seems to have compensated by including a generous 57Wh battery that lasts more than 6 hours in PCMark 8 and 8 hours and 35 minutes during 1080p movie playback.

The C940 has returned with the Yoga's clever Dolby Atmos speaker hinge, a decent keyboard, a fingerprint reader, a physical webcam shutter and a rear mounted stylus, so there's lots of perks here.

The flagship Yoga 2-in-1 gets a performance bump, better battery life and some novel AI-powered features.

★★★★☆

"If we put the Yoga C940 against the Surface Pro 7 with the same i7 CPU and 16GB of RAM the two largely perform at a similar level."

From $2,649 | microsoft.com/en-au

Microsoft Surface Book 3

This device really blurs the line between a tablet and a graphically competent professional workstation.

Much like the Surface Pro line, Microsoft's Surface Laptop 3 takes a lot of elements from its predecessor and updates the core components for a service that's even closer to being the 'desktop replacement tablet' the company pitches it as. The unit returns with either a 13.5-inch or a 15-inch 3:2 PixelSense display at 3000 x 2000 or 3240 x 2160 pixel resolutions, respectively. The smaller size can be configured with either an Intel Core i5-1035G7 or an i7-1065G7 CPU; and a choice of 8, 16 or 32GB of RAM and costs between $2,649 and $4,499. The 15-incher on the other hand only comes as an i7, with either 16GB or 32GB of RAM and ranges between $3,699 and $4,759. If you opt for the more powerful processor it comes with a Nvidia GTX 1650 GPU on the 13.5-inch and a GTX 1660Ti on the bigger model and the accompanying 256G, 512GB or 1TB PCIe SSD storage is pegged to variations in other components, which means you need to pay for more power if you want more storage. The most powerful 15-inch model performed within about 10% either way of the average laptop in the roundup (excluding the fully gaming capable powerhouses here), and performed more than four times better than devices relying on integrated graphics. This is enough for reasonable 1080p gaming and decent graphical workloads. Battery life was solid at six hours and 37 minutes in PCMark 8, which means you'll easily get a full day's work out of it (unless you're leaning heavily on the GPU).

A tablet that's at least as powerful as the best professional ultrabooks and is even a competent gamer and graphics worker.

★★★★½

From $1,249 | microsoft.com/en-au

Microsoft Surface Pro 7

Microsoft continues to add minor refinements to this finely chiseled tablet-laptop.

The only real difference between the confusingly named (5th Gen) Surface Pro, its successor the Surface Pro 6, and the latest Surface Pro 7, is the CPU. All are available in the same four, eight and 16GB RAM configurations and identical 128GB to 1TB storage options. It also uses the same 12.3-inch, 3 x 2 PixelSense display at the same 2,736 by 1,824 resolution as its two most recent predecessors and even fits into the same 29 x 20 x 0.9cm chassis and weighs an almost identical 790g.

The Surface Pro 7's CPU has been updated to one of Intel's latest 10th Gen processors and regardless of whether you get the Core i3-1005G1, the Core i5-1035G4 or the Core i7-1065G7, you will have access to the new faster Wi-Fi 6 networking specification. Microsoft has finally swapped out the Mini DisplayPort for a USB 3.1 Type-C interface, alongside its existing USB 3.1 Type-A port.

In R15 multi-threaded CPU benchmarks, the Core i7 Surface Pro 7 was 31.5 percent better than the Surface Pro 6 and 87.6 percent faster than the Surface Pro (5) and it scored higher than any other quad core CPU in this roundup. The Intel Iris Plus Graphics won't be capable of anything more than light games and graphical workloads, but it roughly doubles the graphical performance of its predecessor. The 46Wh battery gets close to six hours in PCMark 8 Battery Life benchmarks, equating to more than a working day's battery life.

A decent update that improves on power and efficiency in an ultra-compact and portable tablet 2-in-1.

★★★★½

"In R15 multi-threaded CPU benchmarks, the Core i7 Surface Pro 7 was 31.5% better than the Surface Pro 6 and 87.6% faster than the Surface Pro (5) and it scored higher than any other quad core CPU in this roundup."

From $3,498 | msi.com

MSI GS66 Stealth

The pinnacle of power squeezed into an ultrabook.

MSI's website only list the GS66 Stealth's Intel Core i9-10980HK models, so you'd be forgiven for thinking that that is the only CPU this device ships with, but the more common variation sold in Australia actually comes with a Core i7-10750H CPU, the same one that's in most of the laptops here. The most affordable variation we could find was an i7, 16GB, RTX 2060 with a 240Hz 1080p panel and 512GB SSD for $3,498 (which was on sale for $2798.40 at the time of writing). If you do want the wildly powerful Core i9-10980HK CPU with 32GB of RAM, an RTX 2080 GPU, 1TB of storage and a 4K screen, you're looking at a hefty $6,999. In terms of raw performance only the AMD Ryzen 9 4900HS on the Zephyrus G14 and the MacBook Pro 16's Intel Core i9-9880H got close on cross-platform benchmarks. MSI's GS66 was actually outperformed by the Zephyrus G14 on Cinebench multi-threaded CPU tests and was almost matched by it in media encoding, but it took the lead in other general benchmarks. Graphically this laptop benefited from additional RAM and CPU so it beat the only other device in the roundup with a 2080 Super in 3DMark.

At 2cm thick and 2.1kg, the GS66 is one of the largest devices in the roundup, but considering the power you are carrying it's still perfectly portable. We wouldn't choose a 1080p screen on a $7K laptop, and you can easily swap out the 300Hz display for a 4K panel, but for professional gamers this isn't really an option.

A supremely powerful portable workstation that is also capable of commanding games, for a price.

★★★★☆

From $2,099 | au.msi.com

MSI Prestige 14

MSI's wants to get down to business, but it may have needed to do a little more homework.

MSI's got a new Prestige 14 and it looks as slick as anything we've seen in the professional laptop space. Inside this Pure White, Rose Pink or Carbon Gray ultrabook is a 10th-generation Intel Core i7-10710U CPU, 16GB or RAM and a dedicated Nvidia GeForce GTX 1660 GPU – which is plenty of grunt for a day-to-day laptop for most professionals.

While you'd expect this hexa-core chip to be performing alongside the punchier laptops in the roundup, it's actually much closer to the quad-core CPUs in terms of both raw CPU performance and general work capabilities. This is in part because it uses efficient cores with a base frequency of 1.1GHz, but MSI decided to use this advantage to jettison battery capacity. As a result the installed 52.4Wh battery only manages to chug along for two hours and 37 minutes in PCMark 8's Battery benchmark and just 3 hours and 5 minutes in 1080p battery lifespan. This makes it the worst performer of the whole roundup in terms of on-the-go productivity. We ran a configuration with a Nvidia GTX 1650 GPU, which is just enough for light 1080p gaming and decent graphical work, but you can configure this unit with a GeForce MX330 (about the same as a GTX 1050 Max-Q) for graphical performance that's just a bit better than the latest integrated GPUs. This model also came with a 4K HDR screen that offers 100% Adobe RGB colour reproduction and professional-level colour accuracy (Delta E is less than 2) for $2,829, but you can get a 1080p IPS version for less.

A neat looking ultrabook with decent performance and a short battery life.

★★★½☆

"While you'd expect this hexa-core chip to be performing alongside the punchier laptops in the roundup, it's actually much closer to the quad-core CPUs in terms of both raw CPU performance and general work capabilities."

From $3,749 | razer.com

Razer Blade Stealth 13

apc RECOMMENDS

A powerful compact ultraportable that has some new screen tech to show off.

Razer's compact Blade Stealth 13 is one of the few smaller laptops in the roundup to get a dedicated gaming GPU. Pair this Nvidia GTX 1650 Ti with the efficient Intel Core i7-1065G7 processor and 16GB of RAM and you have a very powerful work ultrabook that'll be capable of solid workloads and decent 1080p gaming.

The Blade Stealth 13 matches these internals with your choice of a 13.3-inch 120Hz display (a world first according to Razer marketing materials) or a 4K touchscreen option. Normally we would advise a higher resolution screen on a work machine, but a 13.3-inch display is too small for it to be essential. On the the 120Hz 1080p model it's not critical either, since you're unlikely to get much over 60fps on low 1080p settings in modern games, unless you're playing indies or less demanding titles. That said both are welcome bonuses in your work machine.

While 1.5kg isn't the lightest offering in the roundup, the Blade Stealth 13 is as thin as any clamshell you can get your hands on at 1.5cm and its footprint is as compact as the 13 and 14-inch offerings here.

Battery life wasn't particularly impressive with the 53Wh lithium ion pack getting just 3 hours and 40 minutes in PCMark 8 and a little over five hours in 1080p movie playback. This is great against gaming laptops, but was one of the poorest performers in this roundup. So you'll have to plan to take your charger with you.

A powerful little laptop with impressive visuals that is a little shy on battery, but not on price.

★★★★☆

Razer's Blade 15 is often seen as the MacBook of gaming laptops, but while the 2020 Blade 15 Advanced looks really nice against gaming laptops, it doesn't really stand out in a lineup of professional ultrabooks. What it does offer however is a lot more performance.

The Blade 15 Base and Advanced models are basically split by processor with the former bagging Intel's 2.6-5GHz hexa-core Core i7-10750H and the latter scooping up the 2.3-5.1GHz, octa-core Core i7-10875H. In addition the Advanced model also gets a 300Hz or 4K OLED screen and a Nvidia RTX 2070 Super or 2080 Super GPU and starts at $5,299.

The Blade 15 Advanced pretty convincingly beats all of the quad-core laptops in the roundup, but it actually underperformed against the supposedly less expensive hexa-core i7-10750H on Dell's XPS 15 in raw CPU and media encoding tasks. Fortunately it made up for this by being between 12 and 45 percent better on PCMark general work benchmarks.

The onboard Nvidia RTX 2080 Super meant that it was the second highest performer in the round up graphically, but even with all this power the device managed to last 3.48 hours in PCMark 8's Home Battery test and 6.5 hours in 1080p movie playback. This means you should be able to get a full working day's battery life from the unit in light workloads if you tweak the power settings. The 4K panel also offers a DCI-P3 colour gamut for anyone needing to do professional video editing.

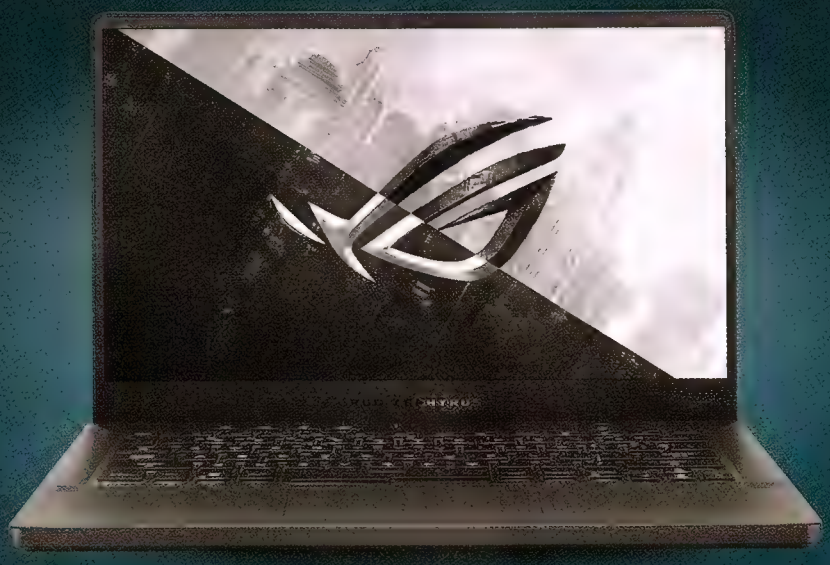
One of the longer lasting powerhouse ultrabooks capable of heavy graphical loads and precise colour reproduction.

★★★★☆

From $5,299 | razer.com

Razer Blade 15 (Advanced)

Can Razer again cut through the competition with its advanced gaming/work rig?



Concluding comments

The 2020 laptop state of play.

While AMD's propensity to add more cores to a processor to get more processing power isn't always the best solution for gaming (which often can't utilise multiple threads anyway) however, this approach seems to be working exceptionally well when it comes to the benefits a professional user might want.

The only unit we gave full marks to in this roundup was the Asus ROG Zephyrus and the main component in making it such a standout performer was the AMD processor it was running. The ROG Zephyrus G14 with a Ryzen 9 4900HS costs $2,799, but it performs as well as something running an Intel Core i9-10980HK, which we can't really find in any configuration locally for under about $5K. This means it's a pretty amazing bargain for those needing a proper workstation processor on the go.

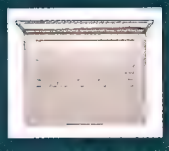
In addition to this excellent price, the Ryzen 9 4900HS also offers some amazing efficiency, lasting for eight hours and 24 minutes in 1080p movie playback, which is more than double the lifespan of some of the more powerful units here. Then throw in an entry-level gaming GPU and a 1.6kg total weight and this device is a truly remarkable configuration from Asus, and we imagine it'll sell pretty quickly (even though it doesn't have a webcam).

Apple back on track

There were quite a few devices that came out ahead of the main pack, each of which had their own distinct qualities. For Apple the MacBook Pro 16 seems like a shift in design choices that returns to a focus on customer feedback. Whether it's little things like fixing the butterfly keyboard reliability by returning to a Magic Keyboard style, or continuing to enhance the colour reproduction of its displays, the MacBook Pro 16 is a signal that Apple is still keen to be a leader in laptop design again. What mainly elevated it this time was price, which seems reasonable in the premium space, and battery life, which is generous considering how powerful this configuration is.

Asus engineering

Asus manages to get another mention for its ExpertBook, which is not the most powerful rig here by a long shot, but it's a laptop that makes a lot of clever design decisions with the processor it got. Bolstering the battery on this lightweight laptop means it had to come up with a new kind of magnesium alloy in order to keep it at the desired weight, but it managed to stick the landing to make a uniquely powerful and long lasting clamshell for professionals that like to travel light.



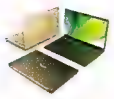
Most of the laptops we tested here will do a fine job of professional tasks, the balancing act that will drive your buying decision will be battery life, and whether gaming prowess is important.

Rising to the Surface

Then there's Microsoft, which hasn't changed much about the overall design of the range, but this consistency allows it to really focus on improving the balance of each device year on year. When you consider that this is the seventh iteration of the Surface Pro, it kind of makes sense that Microsoft is able to make tablets that are actually more powerful than many laptops, and from an engineering perspective that is an extraordinary achievement. There is a price premium for the tablets, but it's very small these days, and if you want a tablet and a laptop then the Surface range is an awesome choice.

"The only unit we gave full marks to in this roundup was the Asus ROG Zephyrus and the main component in making it such a standout performer was the AMD processor it was running."

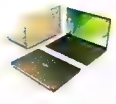
ULTRABOOKS & 2-IN-1s SPECIFICATIONS

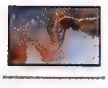


	Acer Swift 5	Apple MacBook Air 2020	Macbook Pro 16 (late 2019)	Asus Expertbook B9450	Asus ROG Zephyrus G14	Dell XPS 13 (2020)	Dell XPS 15 9500
Score	★★★★☆	★★★★☆	★★★★½	★★★★½	★★★★★	★★★★½	★★★★☆
Street price	$2,399	$1,999	$5,599	$3,199	$2,799	$3,699	$4,599
CPU	Intel Core i7-1065G7	Intel Core i5-1030NG7	Intel Core i9-9880H	Intel Core i7-10510U Processor	AMD Ryzen 9 4900HS	Intel Core i7-1065G7	Intel Core i7-10750H
Memory	16GB	8GB	32GB	16GB	16GB	16GB	16GB
GPU	Intel Iris Plus Graphics G7	Intel Iris Plus G7	AMD Radeon Pro 5500M	Intel UHD Graphics	Nvidia GeForce RTX 2060 (Max-Q)	Intel Iris Plus Graphics	Nvidia RTX 1650 Ti
Storage	521GB PCIe ssd	512GB PCIe	2TB Apple PCIe SSD (NVMe gen 2)	512GB NVMe	1TB Intel PCIe SSD	512GB Toshiba NVMe SSD	1TB PCIe SSD
Wi-Fi	Intel Wireless Wi-Fi 6 AX201	802.11ac Wi-Fi	802.11ac Wi-Fi	WiFi 6 (802.11ax)	Intel WiFi 6 AX200	Killer WiFi 6 AX1650s	Killer Wi-Fi 6 AX1650s
Screen size	14-inch	13.3-inch	16-inch	14-inch	14-inch	13.3-inch	15.6-inch
Screen type	IPS	227PPI IPS	500nit Retina HDR	300nit IPS	120Hz	4K 500 it	Touch 500nit
Resolution	1080p	2560 x 1600p	3072 x 1920	1920 x 1080	1920 x 1080	3840 x 2400	3840 x 2400
Screen finish	Gloss	Gloss	Gloss	Matte	Matte	Matte	Matte
Battery capacity Wh	52	49.9	100	63	76	51	84
Dimensions (mm)	318.7 x 210.5 x 14.95	304.1 x 212.4 x 16.1	357.9 x 245.9 x 16.2	320 x 203 x 14.9	324 x 222 x 17.9	14.8 x 296 x 199	344.7 x 230.1 x 18
Thickness (cm)	1.5	1.61	1.6	1.49	1.8	1.5	1.8
Weight	0.99	1.29	2	0.995	1.6	1.27	2.05

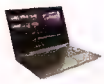
ULTRABOOKS & 2-IN-1s BENCHMARK RESULTS

Indicates best result





		Acer Swift 5	Apple MacBook Air 2020	Macbook Pro 16 (late 2019)	Asus Expertbook B9450	ROG Zephyrus G14	Dell XPS 13 (2020)	Dell XPS 15 9500
PCMark 8	Home (accelerated)	3,542	NA	NA	3,354	4,606	3,230	3,278
PCMark 8	Work (accelerated)	4,800	NA	NA	5,152	5,502	DNT	4,354
Battery (movie playback)	Home Battery (accellerated)	04:25	NA	NA	07:20	04:13	DNT	03:31
Battery (movie playback)	1080p total playback time (H:M)	07:32	07:55	10:53	10:19	08:24	05:50	05:49
Crystal DiskMark 5/6	Sequential read (Q32T1)	1,739	1,153	2,875	3,335	1,761	3,105	3,104
Crystal DiskMark 5/6	Sequential write (Q32T1)	1,453	1,358	2,630	2,317	1,755	2,673	2,874
Cinebench R20	CPU	1,337	855	3,286	1,493	4,224	1,664	2,866
Cinebench R20	CPU Single Core	439	347	476	129	486	453	132
GeekBench 4	CPU Multi Core	16,770	13,772	30,102	18,025	30,011	18,614	24,360
GeekBench 4	GPU Compute	60,494	32,737	97,282	40,128	184,867	63,878	142,936
Temp	Peak CPU temperature (°C)	NA	NA	NA	NA	NA	100	NA
3DMark (2013)	Time Spy	811	526		262	5,799	763	3,772

										
	Gigabyte Aero 15 OLED	HP Spectre x360 13	Huawei Matebook X Pro	Lenovo Yoga C940-14IIL	Microsoft Surface Book 3	Microsoft Surface Pro 7	MSI GS66	MSI Prestige 14	Razer Blade Stealth 13	Razer Blade 15 (2020)
	★★★★☆	★★★★☆	★★★½☆	★★★★☆	★★★★½	★★★★½	★★★★☆	★★★½☆	★★★★☆	★★★★☆
	$4,399	$3,199	$3,298	$1,999	$4,499	$2,449	$6,999	$2598	$4,099	$6,099
	Intel Core i7-10875H	Intel Core i7-1065G7	Intel Core i7-10510U Processor	Intel Core i7-1065G7	Intel Core i7-1065G7	Intel Core i7-1065G7	Intel Core i9-10980HK	Intel Core i7-10710U	Intel Core i7-1065G7 Processor	Intel Core i7-10875H
	16GB	16GB	16GB	16GB	32GB	16GB	32GB	16GB	16GB	16GB
	Nvidia GTX 2070 Super	Intel Iris Plus Graphics	Nvidia GeForce MX250	Intel Iris Plus Graphics	Nvidia GeForce GTX 1660Ti	Intel Iris Plus Graphics	Nvidia RTX 2080 Super	Nvidia GeForce GTX 1660(Max-Q)	Nvidia RTX 1650Ti (Max-Q)	Nvidia RTX 2080 Super
	1TB PCIe SSD	512GB Intel SSD with 32GB of M.2 Optane SSD memory	1TB NVMe	1TB PCIe SSD	1TB NVMe	256GB Hitachi PCIe SSD	1TB PCIe SSD	1TB WD PCIe SSD	512GB NVMe	512GB PCIe SSD
	Killer Wi-Fi 6 AX 1650	Intel Wi-Fi 6 AX 201	IEEE 802.11a/b/g/n/ac	11ax, 2x2, Wi-Fi	Wi-Fi 6: 802.11ax	Intel Wi-Fi 6 AX201	Wi-Fi 6: 802.11ax	Intel Wi-Fi AX201	Intel Wireless-AX 201	Intel Wireless AX201
	15.6-inch	13.3-inch	13.9-inch	14-inch	15-inch	12.3-inch	15.6-inch	14-inch	13.3-inch	15.6-inch
	AMOLED	4K OLED	260ppi	400 nitt multitouch	PixelSense 267PPI	PixelSense Touchscreen	300Hz	IPS	4K	300Hz
	3840 x 2060	3840 x 2160	3000 x 2000	3840 x 2160	3240 x 2160	2736 x 1824	1920 x 1080	1920 x 1080	3840 x 2160	1920 x 1080
	Matte	Gloss	Gloss	Gloss	Gloss	Gloss	Matte	Gloss	Gloss	Matte
	94	60	55	57	82	46	92	52.4	53	83
	356 x 250 x 20	306.70 x 194.00 x 16.90	304 x 217 x 14.6	320.3 x 215.6 x 1.6	343 x 251 x 23	292 x 201 x 8.5	358.3 x 248 x 19.8	319 x 215 x 15.9	304.6 x 210 x 15.3	355 x 235 x 17.8
	2	1.7	1.5	1.6	2.3	0.9	2	1.6	1.5	1.8
	2.1	1.3	1.35	1.4	1.905	0.79	2.1	1.29	1.48	2.2
	Gigabyte Aero 15 OLED	HP Spectre x360 13	Huawei Matebook X Pro	Lenovo Yoga C940-14IIL	Microsoft Surface Book 3	Microsoft Surface Pro 7	MSI GS66	MSI Prestige 14	Razer Blade Stealth 13	Razer Blade 15 (2020)
	3,742	3,127	3,142	3,832	3,086	3,332	5,182	3,514	3,387	4,753
	4,655	DNT	4,282	5,006	4,320	4,536	5,842	4,946	4,260	5,815
	04:41	03:35	03:09	06:01	06:37	05:05	02:45	02:37	03:40	03:48
	06:10	04:40	10:37	08:35	08:41	05:56	03:15	03:05	05:02	06:30
	2,473	2,447	3,452	3,560	2,253	2,001	3,433	3,371	3,410	3,198
	1,522	1,245	2,793	2,985	1,467	832	2,376	3,091	2,261	2,113
	3,397	1,433	1,366	1,568	1,590	1,765	3,744	1,429	1,307	2,436
	478	420	437	153	274	281	489	368	441	479
	31,197	18,742	14,605	18,482	15,317	18,913	31,554	16,536	16,301	20,431
	215,837	64,431	43,530	61,032	176,260	63,930	233,949	112,126	122,792	221,593
	NA	100	99	100	100	96	NA	92	NA	NA
	7,459	538	909	702	4,242	885	7,843	2,702	2,975	7,333

FEATURE

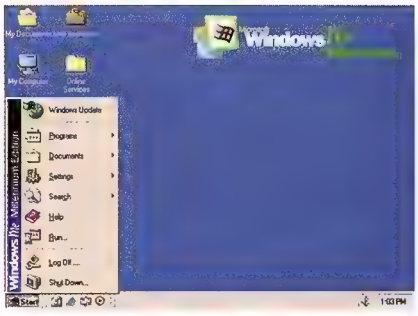
LICENCE TO FAIL

Join Christian Guyton for a walk down memory lane as we recall the 20 biggest computer industry flops of the last 20 years.

The consumer technology field is, without a doubt, an absolute hotbed of technological innovation. Over the last few decades, we've seen computing make incredible strides in processing power, graphical capability, and data storage. There have been inspired new moves, like the introduction of simultaneous multi-threading and hyper-threading to double the available threads of CPUs, as well as improvements to software, hardware, and network infrastructure that have made things like 4K video streaming a reality. It wouldn't be an overly bold claim to say that the PC hardware industry and community are in the best place they've ever been (any global pandemics notwithstanding, of course).

However, it hasn't always been happy faces and full coffers in the computing industry. There have been mistakes, bad judgements, humiliating missteps: Some tragic, some hilarious. It's not uncommon for a brand to release a product or service they firmly believe is going to be the Next Big Thing, then throw all of their marketing resources behind it only for it to fall flat on its face, selling like a *Boyz II Men* Christmas album in early April.

The past two decades have brought us some incredible innovations, but plenty of flops as well – and they are what we're going to focus on today, in pursuit of comedy and perhaps a few cautionary tales.



20
Windows Millennium Edition

It seems fitting to start with Microsoft's turn-of-the-century blunder, Windows Me. That's "Millennium Edition", in theory. In practice, it was dubbed the "Mistake Edition," with a cavalcade of issues plaguing it after release. Sometimes it would refuse to function with existing software; sometimes it would refuse to start up at all. Microsoft scrambled to fix the stability issues and numerous glitches, releasing patch after patch, but the damage was done, and Windows Me was immortalised as one of the worst operating systems ever to be released.

19
Seagate Barracuda 7200.14

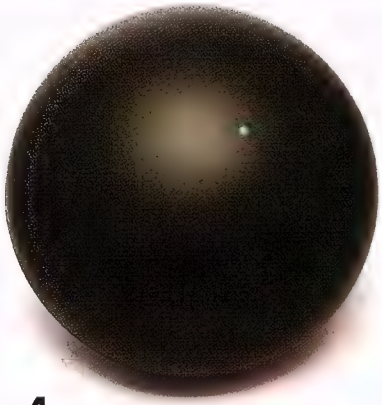
There was an awful lot of drama around this one. In 2008/2009, customers around the globe reported drive failures and data loss using Seagate's 7200.11 hard drives. The issue was identified as a firmware problem, and led to a demonstrably higher rate of failure in the 7200.14 and other drives in the family. Seagate did release a firmware update and offered free data recovery services for affected drives, but the damage was done. The manufacturer was also accused of censoring posts on its forums that discussed the failing drives, leaving many customers angry.

18 OQO

It's a tiny Windows system! The first OQO device, the Model 01, actually had a lot going for it, including Bluetooth connectivity and a Wacom-designed stylus, but sadly the technology just wasn't there yet. The five-inch LCD display was too small to properly encapsulate the excellence of Windows XP (still, to this writer's mind, the greatest OS of all time), and the initial OQO handheld was released before Microsoft finalised the Tablet PC Edition of XP. Attempting to run XP Professional on this tiny tablet was, by all accounts, hellish. OQO soldiered on to release four more models, but sadly declared bankruptcy in 2009.

17 Google Glass

Glass was a cool piece of tech, but the world wasn't ready for augmented reality glasses in 2013. Wearable tech is swiftly finding more of a purchase in our society, so we wouldn't be surprised to see a triumphant return for Glass in a few years' time – Google is already marketing a reworked version to enterprises. The original Glass, though, was branded by many as a privacy-invading badge of purported intellectual and financial superiority, and it was wound down after nine months.



16 HP TouchPad

HP's modern Windows tablets and convertibles are top-notch hardware (we adore the sleek and silent Spectre x360 2-in-1), but the computing giant was late to the party. The TouchPad was supposed to be HP's answer to Apple's wildly successful iPad, but the late Steve Jobs held a killer keynote not long before the TouchPad's release, announcing the iPad 2. The products released within the same window, and the world was busy fawning over Apple's latest gem, so the TouchPad sunk into obscurity with alarming speed. The wonky OS didn't do it any favors, either.

15 Facebook Portal

Little more than a glorified monitor for easier video calling, the Facebook Portal released in 2018 to minimal fanfare. With allegations of data theft and privacy invasion being thrown in every direction, consumers were – perhaps unsurprisingly – reluctant to spend hundreds of their own hard-earned dollars to install a Facebook-controlled camera and microphone in their homes. Critics also tore the product to pieces, and some fairly murky language from Facebook surrounding the data-gathering functions of the Portal didn't help matters. Although the social media titan has since launched a 2nd generation of the product, the low sales of the original Portal mark it as something of a misstep for Facebook.

14 Google Nexus Q

Another early effort to cash in on the home media streaming boom, the Nexus Q was a weird little orb that could stream content from YouTube, Google Play, and... no, that was everything. The limited content library, high asking price, and clunky user interface meant that the Nexus Q was never destined for greatness. The killing blow was undoubtedly the fact that speakers were not included by default. The product never even made it to a full release; the public launch was indefinitely postponed while production wound down in favor of the Chromecast, and some early adopters were even given the product for free, albeit without ongoing Google support.

13
Windows 8

It was bad, wasn't it? This might be the item on this list that is freshest in most people's memories, especially given that it is still widely used. The goal was to create a "best of both worlds" OS, ideal both for desktop PCs and tablets, where Microsoft's Surface line was in hot competition with iOS. Unfortunately, Windows 8 proved slow on portable devices and clunky on desktops, with a fiddly Start screen formed of numerous tiles of varying sizes. A metric tonne of preloaded bloatware was the final nail in the coffin. Windows Vista might have been the subject of many IT department jokes for years, but Windows 8 was not such a laughing matter: It simply wasn't good.

12 Microsoft Surface RT (& Windows RT)

The Surface RT brought us the worst of both worlds. A mediocre tablet with a massive bezel and a broken, confusing OS. Windows 8 was already in dire straits with low adoption figures, but the version that Microsoft adapted for the lightweight new tablet's 32-bit ARM-based processor was an utter mess. Software compatibility was poor from the outset, and the OS frequently ran slowly or failed to launch Windows Store apps. The tablet itself was fine but unimpressive next to the other Surface models. It was a massive commercial failure for Microsoft, costing the company somewhere in the region of US$1 billion as unsold tablets were discarded en masse.

11
Nvidia GeForce GT 1030 DDR4

The original GDDR5 version of Nvidia's GT 1030 was a perfectly serviceable low-end gaming GPU, ideal for 720p and sometimes 1080p in less-demanding games. It was also modestly popular for cryptocurrency-mining rigs, and sales were strong thanks to a sensible asking price of around $100. The problems arrived when Nvidia quietly released a new model with DDR4 memory transplanted in. Despite having about a third of the original's memory speed, it wasn't much cheaper, and many uninformed buyers ended up with a crap card that often failed to hit even 30fps at 1080p. The only real advantage was the somewhat lower TDP, and since some third-party manufacturers were unclear about which memory type their cards used, buying a GT 1030 became a very risky endeavor. A rather embarrassing boo-boo for Nvidia.

10
Radeon R9 285 2GB

This model of AMD's successful Radeon R9 series of GPUs wasn't really a bad product, it was just a victim of bad timing and sub-par marketing. Released shortly after the R9 280, the 285 only offered modest performance improvements of a few percent against its predecessor, along with an unimpressive 2GB of VRAM and DirectX12 support that wasn't widely used at the time. It mostly just served to clog up the market, as the R9 280 was already a decent GPU. A price drop followed almost immediately after release, as Nvidia released the superior GeForce GTX 970, further diminishing the R9 285's legitimacy. Ultimately, this card had little impact and faded into obscurity.

09
Google Fiber

Okay, so this one actually did enjoy some limited success, although things didn't really go according to Google's plan. It managed to get the ball rolling, but progress was slow and costly, with proper fiber broadband and phone services ultimately only reaching nine locations across the planned entire United States. Google burned through billions of dollars digging up US roads and installing fiber-optic cabling, but saw less than half a million customers in 2016, even after five years of work. Google hasn't given up yet – just last year, the corporation laid 1,000km of fiber-optic cables in San Antonio, Texas – but the corporation has also had to pull out of Louisville, Kentucky, amid claims of poor workmanship.

08
Google Daydream

Oh Google, we're surprised to see you appear so many times on this list! Hang on, let us check our notes... no, actually, we're not surprised at all. Google's ill-fated foray into virtual reality was barely able to trade blows with its main competitor, Samsung's Gear VR, since it launched too late to make an impact. Smartphone-based VR was already struggling in the face of the more powerful PC-tethered Oculus Rift and HTC Vive headsets, and we now have fully wireless all-in-one models like the Oculus Quest, which incorporate a compact gaming system inside the VR headset itself. The other main issue that hamstrung Daydream was a lack of variety in its software library. Despite being touted as a great new platform for Android VR, many phone manufacturers and developers took no steps to accommodate or support it.

07
Skype

How do you blow such a hefty lead? Skype rocked up early to the video-calling arena, launching way back in 2003 and cornering a major chunk of the market, mostly due to lack of competition. The app was so successful at first that its name became unanimous with video-calling as a whole: To "Skype" someone often just meant to video call them, regardless of platform.

Of course, success in the tech industry always draws in the big fish, and Microsoft snapped up Skype in 2011 for almost US$9 billion. At the time, the service had over half a billion users worldwide, but it's been downhill since. The coronavirus pandemic has seen an uptick in use, but early 2020 saw daily usage figures of lower than 30 million. Other (read: better) services like Zoom and Discord have diluted the market despite Skype's huge head start. Not even specialised hardware could save it.

06
Apple "Butterfly Keyboard"

The butterfly keys are an example of Apple refusing to admit when it got it wrong. The design (first introduced in the 2015 MacBook) allowed for a thinner laptop thanks to a flat key switch that was hinged in the middle, instead of two hinges on either side that crossed in the center. This made it more vulnerable to small debris getting trapped under the keycap and preventing the key from functioning. Defunct keys, sticking, and unintentional double-pressing were common problems, but Apple was quick to deny that the butterfly keys were the problem. Repairs from Apple itself were costly, as often the entire keyboard would need replacing. Multiple iterations of the butterfly key attempted to fix the issues, but were only met with moderate success. Last year, Apple released a new MacBook Pro, and the butterfly keyboard was conspicuous in its absence.

05
So, so many Linux distributions

Linux is a fantastic platform, with a number of highly recommended distributions such as Arch or the excellent elementaryOS. However, the open-source nature of Linux means that it has seen some dodgy iterations. Some are simply unimpressive, like Mint, which runs like Ubuntu with a few limbs lopped off, but others reach beyond the territory of merely bad and into the domain of weird and twisted. The bizarre Moebuntu plasters the classic Ubuntu UI with anime girls and pastel colours, while the now-legendary Hannah Montana Linux tried to entice young women into the computing field with a bright pink desktop and images of the Disney Channel-era Miley Cyrus character. Some aren't quite so innocent, though, with more dubious distros like the North Korea-endorsed Red Star OS, which entirely restricts access to the wider internet. Then there's "Ubuntu Satanic Edition," supposedly the OS of choice for Satanists around the world.

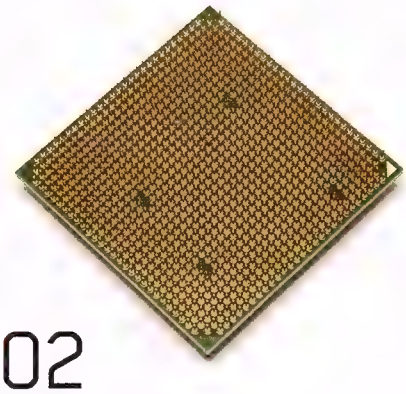
04 OnLive

OnLive was a cloud gaming platform that promised to do everything Stadia has difficulty doing today. Suffice to say, things did not go well. Mixed critical reception and poor performance thanks to a fundamental lack of internet infrastructure doomed the product from the outset, despite a number of decent features, such as download-free game demos and broad device compatibility. Most games experienced input lag, as the average American internet speed was below 10Mbps during OnLive's main period of operation. An OnLive home console was launched in 2010, but failed to make any impact. Although the company was supposedly doing well and expanded into the UK with some success, plans to bring the service to Europe were scuppered after mass layoffs in 2012. An attempt to revive the firm with a new service called CloudLift failed. The dissolution of the company saw its assets sold to Sony for a fraction of their original worth, despite being valued at nearly US$2 billion at its peak.

Google+

03 Google Plus

Google Plus, taken from us before its time. Google has something of a reputation for abandoning products and services once they are deemed unprofitable (hello Google Wave), but the final Google property on our list kept stumbling onwards for years, somehow surviving data leakage scandals and poor user retention, until Google finally took it out back and put it down with a battered old Winchester 73 in 2019. It's almost a shame, especially when seeing how other Google properties like Drive and Gmail have flourished over the last few years and evolved into an excellent web of interconnected services. G+, as it was often called, was supposed to be the Google-powered social network, going up against both platforms like Facebook and more professional services like LinkedIn. While initial growth was solid, interest waned as its competitors grew. Censorship in China and Iran only drove controversy, but the most damning thing was undoubtedly Google's attempts to tie YouTube commenting to G+ accounts. People were extremely unhappy, and the mandatory Google Plus integration was scaled back a few years later.

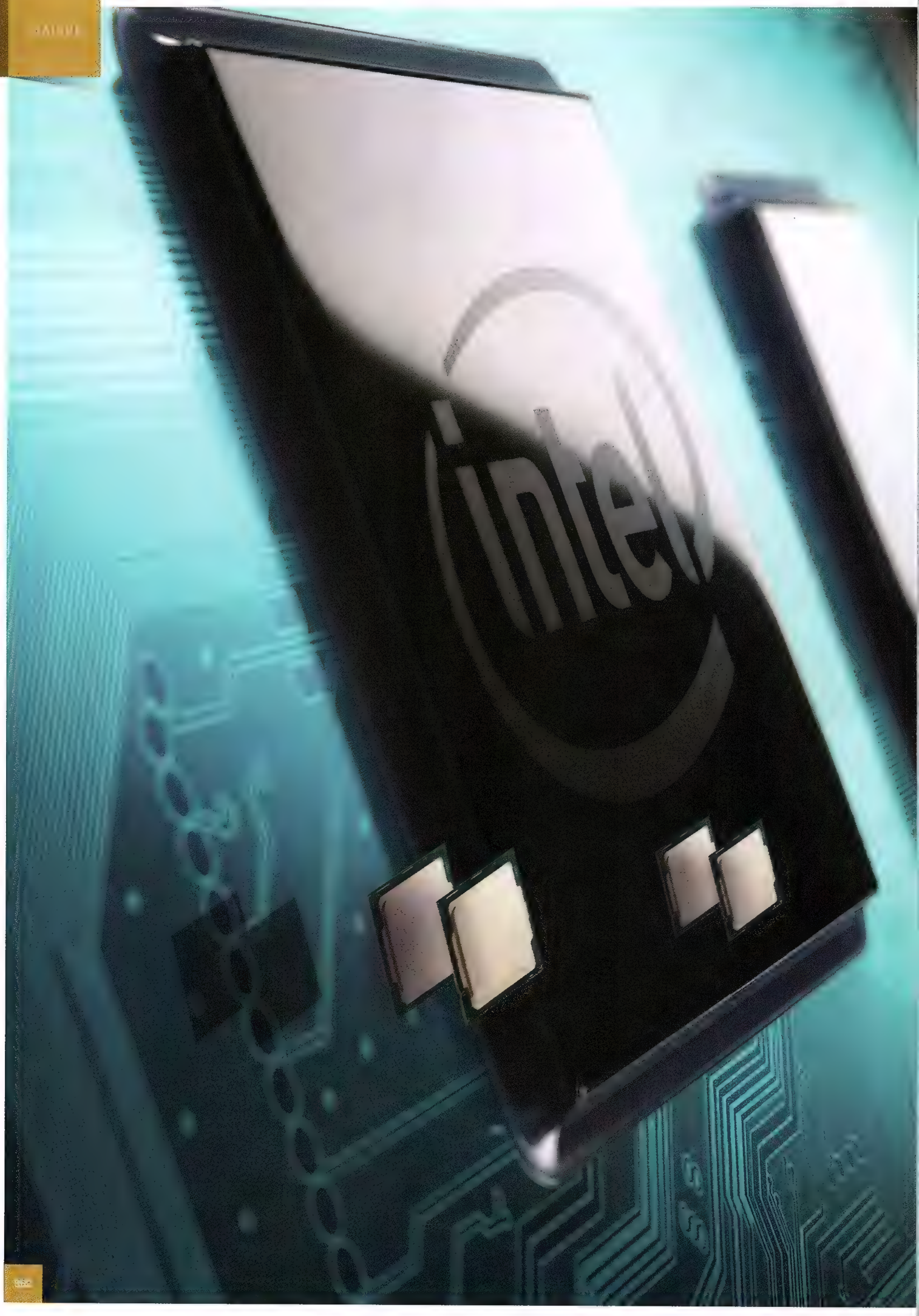


02 AMD Bulldozer

The Bulldozer processors (such as the AMD FX-8150) were a brand-new type of chip from AMD, not building on previous versions but instead starting with a fresh approach to the processor's microarchitecture. Released in 2011, the new family of chips was met with a mixed response. Linux performance was sub-par, while Windows systems saw the Bulldozer CPUs glugging down watts like a sailor at closing time. By using "modules" that were recognized by systems as two processor cores, AMD was theoretically able to shrink the design without losing performance. This didn't pan out so well, though, as the new chips just couldn't hit the performance levels needed. Although Microsoft released a handful of updates over the years that improved Bulldozer performance in Windows, the damage was done. Supply issues and prominent Intel marketing moves dogged the Bulldozer chips for years, and reviews were hardly overflowing with praise. When AMD was embroiled in a false advertising lawsuit in 2015 over the description of the processor modules as "dual-core," it seemed like a final blow from Bulldozer. It was the last we ever heard of AMD's first HGV-themed processor family.

01 Steam Machines

We know we're verging into console territory here, but let's be honest: Steam Machines were always just lightweight gaming PCs in a home console shell, perfect for couch gaming. They promised a lot, from access to the vast library of games available on Steam, to a price point competitive with mainline consoles. It also launched alongside the Steam controller, a somewhat polarising piece of hardware but theoretically a good idea. These systems also came with SteamOS, a new Linux-based operating system that had been built from the ground up for gaming. On paper, they should've worked. But then reality had to go and rough it all up. A messy array of Steam Machines were released at once, instantly muddying the waters for console gamers who were considering making the switch. They weren't any cheaper than home consoles, and compact designs led to average performance. Demand was mediocre at best. Although Valve kept updating it for years, SteamOS never became a household name. Steam Machines were beset with one difficulty after another. Free upgrades to Windows 10 served to further lessen the need for SteamOS. Many Steam Machine models were criticised for their lack of easy upgradeability – a cornerstone of the PC gaming community. Valve began to distance itself from manufacturers and eventually released Steam Link, which enabled the streaming of games from a PC to a TV. Valve may have found some success with the new Index VR headset, but we feel comfortable in declaring Steam Machines the number one PC hardware flop of the last 20 years. ■


intel

THE EMPIRE STRIKES BACK

After more than a decade of dominance, Intel has fallen behind its main rival, AMD. Jeremy Laird investigates where Intel went wrong and how it will fight back.

What, exactly, has happened to Intel? The once unassailable leader in both PC processors and chip manufacturing generally now looks second best by almost every conceivable technological metric. AMD's CPUs appear cleverer. TSMC's manufacturing technology seems more advanced. Intel, it seems, has completely lost its way.

Even in the mobile PC space, which Intel has absolutely owned for decades, AMD's new Renoir APU has the edge. Likewise, how is it that AMD has offered PCI Express 4.0 on desktop PCs for a year, but Intel hasn't even announced future support for what is a crucial high-speed interconnect?

Things are so bad that Apple is said to be planning to ditch Intel in favor of its own ARM-based processors. Worse, Intel itself is rumored to be considering TSMC as a manufacturing partner for selected future products, including its first consumer graphics card in decades. Truly, that would be the ultimate humiliation.

Or would it? Last year, despite those issues, Intel enjoyed record revenues of US$72 billion. In fact, in pure commercial terms Intel's main problem has been keeping up with demand for its chips from so-called hyperscalers. That's the likes of Amazon, Microsoft, Google, Facebook et al, who simply can't get enough of Intel's Xeon processors. Meanwhile, there are good reasons to think that Intel will soon be back on track when it comes to both chip manufacturing and CPU architectures.

What single thing summarises Intel's woes? Try "10nm." Chip production technology isn't Intel's only failing – a strong case could also be made for the company becoming ever more complacent over the past decade when it comes to CPU architectures – but 10nm? What a disaster.

By 10nm, of course, we mean a specific production process or node used to manufacture computer chips. The measurement 10nm refers, in theory, to the size of the smallest features inside the chip. In practice, the monikers attached to production processes and the actual size of components like transistor gates inside a PC processor have become somewhat estranged in recent years. There probably isn't any individual feature that actually measures 10nm within a "10nm" Intel CPU.

"Intel has upped the ante to 10 cores for mainstream desktop processors."

That arguable lack of direct correlation between feature size and the description of a given node becomes even more problematic when it comes to comparing process technologies from competing manufacturers. But more on that in a moment. For now, what matters is that 10nm is Intel's latest production process and surely its most troubled. Originally, 10nm was due to arrive way back in 2015. Here, in the second half of 2020, 10nm still only makes up a small minority of Intel's production. You can't buy a 10nm desktop or server CPU from Intel. Only mobile processors for laptops and tablets have moved to 10nm, and even then just some of Intel's low and ultra-low-power range have moved to 10nm. Others have been refreshed on 14nm.

The context for all this – the self-imposed metric by which Intel can unambiguously be said to have fallen short – is Moore's Law. For the uninitiated, Moore's Law is the assumption that computer chips either double in complexity or halve in cost – or some mix of the two, depending on your objectives – every couple of years. It dates back to observations made between 1958 and 1965 by Intel co-founder Gordon Moore. It has since proven remarkably prescient. At least it did until the last decade, when the first signs emerged that chip engineers were beginning to bump up against the laws of physics.

But the wider trials and tribulations of semiconductor manufacturing – as individual transistors approach the size of a handful of atoms and begin to suffer from arcane quantum effects such as tunnelling – are a story for another day and another feature. It's the specifics of Intel's 10nm process that matter for now.

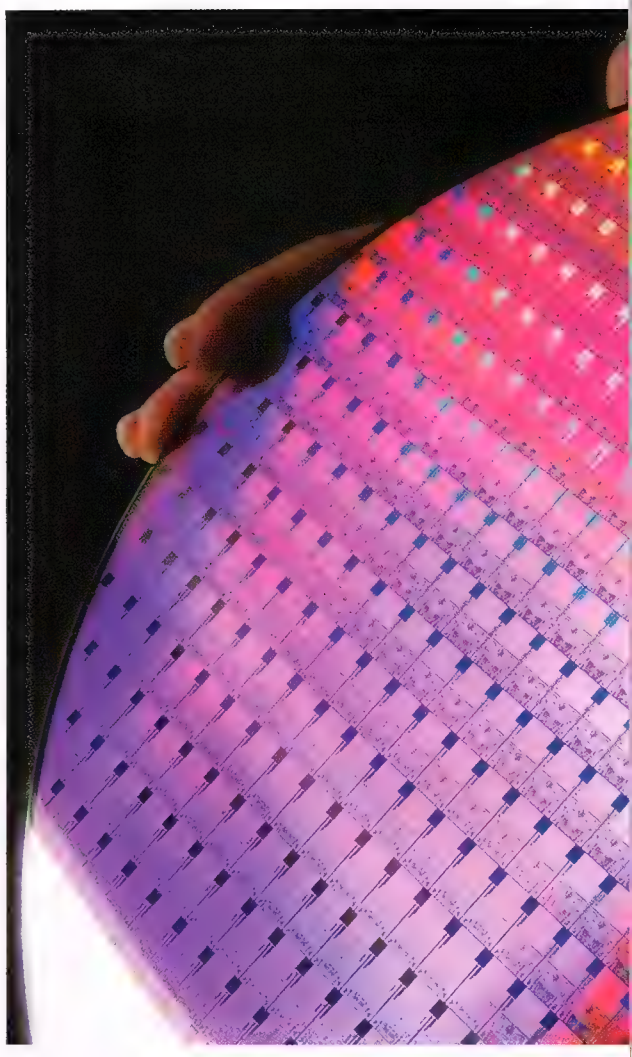
Very likely, Intel's problems boil down to a combination of over-ambition, the end of the line for a certain manufacturing technology, and, just maybe, complacency and a lack of investment. According to Intel CEO Bob Swan, Intel's problems with 10nm are "somewhat a function of what we've been able to do in the past, which in essence was defying the odds. At a time when it was getting harder and harder, we set a more and more aggressive goal. From that, it just took us longer."

Chip ambitions

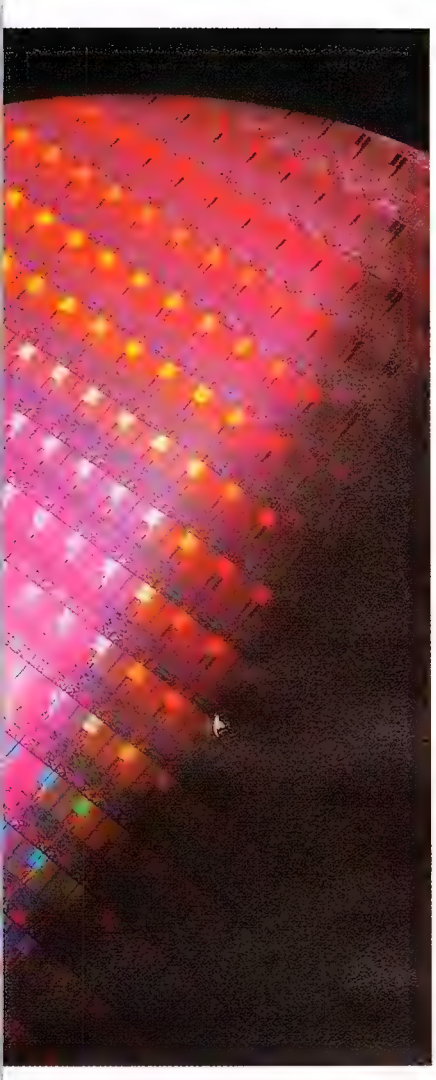
For the 10nm node, that aggressive goal means improving transistor density by a factor of 2.7. In other words, for a given area of processor die area, the 10nm node contains 2.7 times as many transistors as the previous 14nm node. If it's more numbers you want, the 14nm process clocks in at 37.5 million transistors per square millimeter, while the 10nm node achieves just over 100 million by the same metric. That dramatic advance in density makes 10nm demonstrably more aggressive than other recent node transitions from Intel. The 2.5 times step from 22nm to 14nm was quite impressive, but 32nm to 22nm represented a density improvement of 2.1 times, while 45nm to 32nm was pegged at 2.3 times.

Comprehension of these variable density improvements helps to explain the aforementioned difficulty comparing production nodes from competing manufacturers. By way of example, Intel's 10nm density of 100.8 million transistors per square millimeter is actually slightly superior to the 96.5 million transistors achieved by rival manufacturer TSMC's initial 7nm node (TSMC claims 113.9MTr/mm2 for its refined 7nm node). All three of Samsung's 7nm nodes also come in at slightly under the 100 million mark.

The point is that Intel's 10nm was very ambitious – ambitious enough that in 2017 Intel applied the "Hyper Scaling" label to the increase in density it achieves. With the benefit of hindsight, that ambition now looks like overreach. That's because Intel made 10nm its final process node based on existing deep ultraviolet lithography (DUV) manufacturing technologies. To cut a long story short, the size of features in a chip are a function of the wavelength of light used in the lithography processes that etch features into the surface of silicon



Intel is finally cranking out viable 10nm wafers.



THE ULTIMATE HUMILIATION?

Is Intel planning to use TSMC to manufacture its new Xe graphics?

As rumors go, this is a real eye-catcher. Could Intel be in negotiations with rival chip maker TSMC to manufacture its upcoming Xe graphics chips? Ostensibly, it would be the ultimate humiliation, the final insult to the troubled 10nm node. Intel's 10nm node is so bad, the cries will go, they skipped their own fabs and went outside the company to get access to a decent manufacturing process.

Of course, it is just a rumor. Were it to happen, very likely it would be a temporary measure. You could even argue that it is the prudent, risk-averse option, given that TSMC has been producing nearly all the world's high-performance graphics for a decade or more. If you wanted to de-risk GPU manufacturing, TSMC would be your choice.

Anyway, at worst it would buy time for Intel's 7nm process to come on stream. Moreover, the GPU market is notoriously difficult to break into. The last time Intel tried, with the ill-fated Larrabee architecture, consumer variants were cancelled before they even made it to market.

In that context, expectations for 1st-gen Xe products probably ought to be kept quite firmly in check. These products are perhaps better thought of as tools to help Intel accrue feedback, polish its drivers, and learn from any mistakes before the real push comes with 2nd and 3rd-generation products later down the line.

wafers, from which the likes of PC processors are eventually cut.

It's not a direct relationship. Various techniques and tweaks such as masks are used, in effect, to act as multipliers, reducing feature sizes beyond the actual wavelength of the light in question. Chip production facilities, or fabs, with the most advanced DUV technology, including Intel's 10nm products, use ultraviolet light with a wavelength of 193nm. Even so, there is a limit to the transistor density that can be achieved with a given wavelength. Intel was pushing up against that limit with 10nm using DUV technology.

The result, infamously, has been a delay of as much as five years, a relative aeon in the context of Intel's track record and Moore's Law. Even now, there are signs that 10nm isn't what it ought to be. The new 10th-generation Ice Lake mobile processors, for instance, actually clock lower than their 14nm predecessors. The fastest 10nm Ice Lake Core i7-1065G7 CPU tops out at 3.9GHz. The 8th-gen Core i7-8665U is fully 900MHz faster. That's a heck of a gap, and it's symptomatic of a production process that isn't quite right.

Another indicator that 10nm still isn't what Intel would really have wished for is the peculiar doubling up of 10th-gen low-power CPUs. Alongside those Ice Lake chips is the new Comet Lake family, also dubbed 10th generation. Like Ice Lake, mobile Comet Lake comes in low and ultra-low-power formats. But unlike Ice Lake, it is a 14nm family, not 10nm, and extends to six-core models and up to a peak clockspeed of 4.9GHz.

The upshot of which is that, right now, you can buy a laptop with a CPU branded with Intel's latest 10th-gen logo. But what's inside can vary dramatically. If it's dual or quad-core, it may be low or ultra-low power. It might be 14nm or 10nm. It could be based on the Skylake architecture from 2015, or a brand new architecture with the latest Sunny Cove CPU cores, as seen in Ice lake.

Architectural woes

Speaking of Sunny Cove, it brings us rather neatly to Intel's other major failing beyond manufacturing, namely architectures. Up until the release of 10th-generation Ice Lake CPUs for ultra-portable laptops late last year, Intel's entire CPU product stack for desktops, laptops, and servers was based on the 14nm process that debuted in 2014, and the Skylake architecture of 2015. Both have been revised on numerous occasions, but the updates were just that – revisions, not step changes.

What's more, since at least 2008 and the Nehalem architecture, Intel has offered a maximum of four cores for mainstream desktop processors. You could argue that quad-core for mainstream desktops even predates Nehalem. But at the very least, Intel's mainstream offerings remained quad-core at best from 2008 until the release of the Coffee Lake update to Skylake in 2017, and with it an increase to six cores. For nearly a decade, Intel didn't increase its mainstream core count.

Fast-forward a little over two and a half years, and Intel has upped the ante to 10 cores for mainstream desktop processors with Comet Lake, yet another respin of Skylake and yet another family of 14nm processors. So, that's nothing for nearly 10 years, then a 2.5 times increase in the space of just a few. The reason for this dramatic increase in core count after such sustained stagnation? That'll be AMD's Zen architecture and Ryzen CPUs, the

PLOTTING A ROUTE OUT OF 10NM

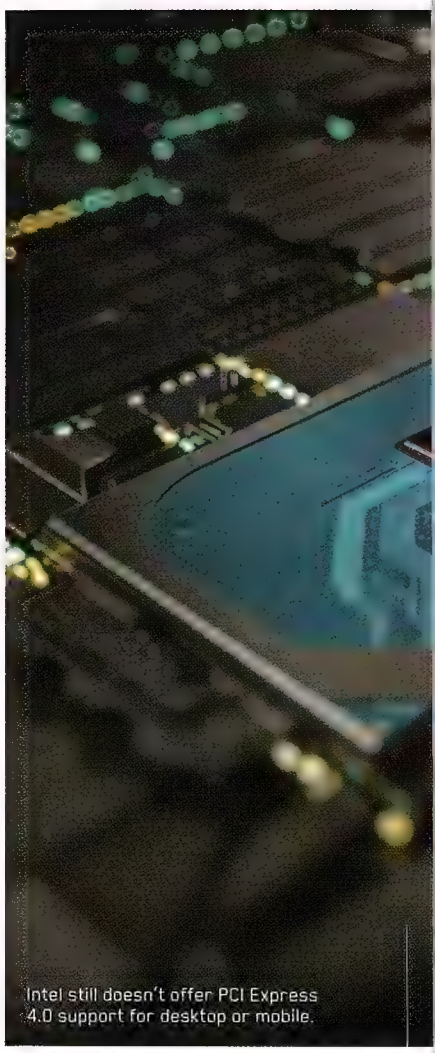
Intel's roadmap to 7nm and beyond.

If Intel isn't going to be fully on track before its new 7nm node, due out late next year, and realistically not a source of really high-volume manufacturing until 2022, what are Intel's plans to stay competitive between now and then? After all, AMD won't be standing still and says it will release another iteration of its Ryzen CPU, powered by Zen 3 architecture, later this year.

When it comes to Intel roadmaps of late, suffice to say that everything is subject to change. However, all the indications are that Intel will stick with 14nm for its next family of desktop processors thanks to an approach known as backporting.

Intel will take the Willow Cove architecture, originally designed for the 10nm node, and backport it to 14nm. Willow Cove is thought to offer roughly 25 percent more performance per clock than Skylake, making for very powerful CPU cores. The new chips, known as Rocket Lake, are due out later this year and are expected to top out at eight cores. Apparently the large Willow Cove CPU cores are quite power-hungry when manufactured on 14nm, preventing Intel from going beyond eight cores. With Rocket Lake, Intel will finally offer a desktop CPU with support for the PCI Express 4.0 interconnect.

Then comes the first 10nm architecture, Alder Lake, which gets faster Golden Cove cores. But the radical departure will be a new big.LITTLE philosophy, which combines small, power-efficient cores with larger, high-performance cores – so Atom cores alongside Golden Cove cores.



Intel still doesn't offer PCI Express 4.0 support for desktop or mobile.

first generation of which arrived in early 2017. Put simply, Intel got somewhat lazy during the pre-Ryzen period, when AMD offered limited competition.

Even at 10 cores, of course, Intel is still a long way behind the 16 cores AMD currently offers in the mainstream desktop space with its 3rd-generation Ryzen processors, which have the benefit of TSMC's cutting-edge 7nm process. In the mobile space, it doesn't look much better for Intel. AMD's latest 7nm Renoir APU brings eight Zen 2 cores into the low-power 15W segment. Intel can only muster a six-core Comet Lake Core-i7 10810U to compete, a processor with a mere 1.1GHz baseclock. The 15W Ryzen 7 4800U packs eight cores and a 1.8GHz baseclock. It's not a flattering comparison.

"Next up is Golden Cove, which will be a bigger step forward late next year."

Looking to the future

So that's the case for the prosecution. It hasn't been a great few years for Intel from a technology perspective. As Intel's CFO, George Davis, said of the 10nm debacle: "This just isn't going to be the best node that Intel has ever had. It's going to be less productive than 14nm, less productive than 22nm." But is Intel's predicament really that disastrous?

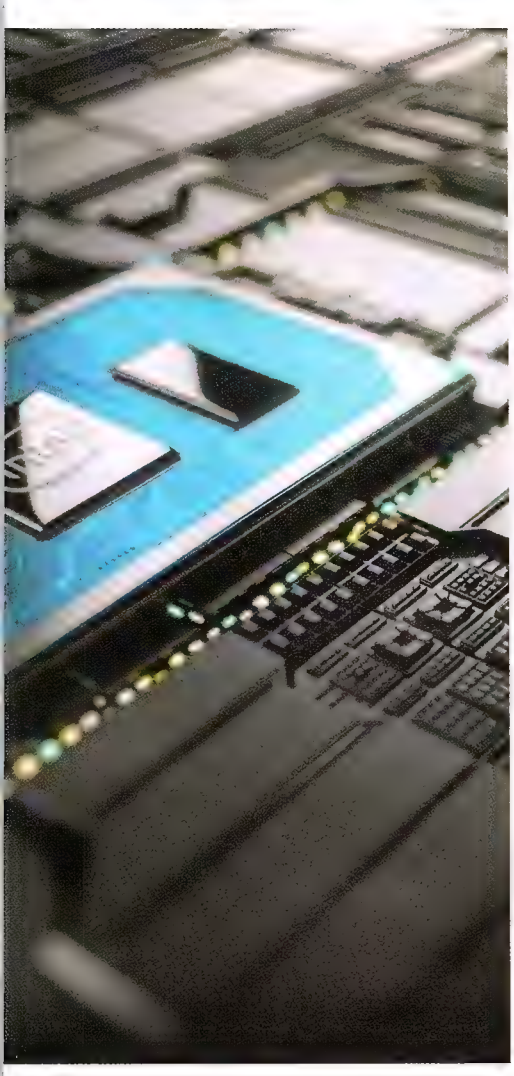
In pure financial terms, the resounding answer is no. In fact, not only is the situation not that bad, there's no problem at all. 2019 was a record year for Intel revenues. Since the middle of 2018, far from sales falling off due to technological stagnation, Intel has been struggling to keep up with demand for its 14nm chips.

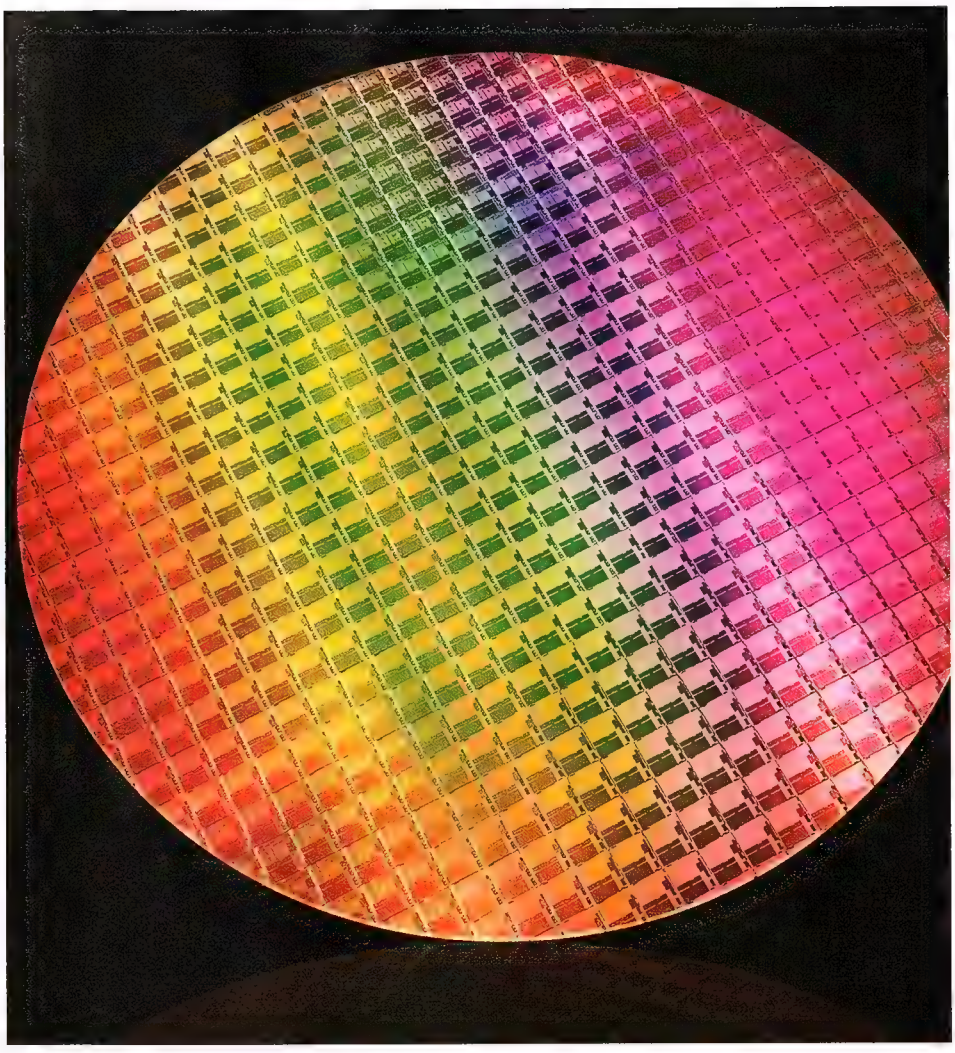
Dig a little further into the details, and it seems likely that at least part of the problem is still technological. Intel's server chips have increased in core count dramatically during the 14nm era. Intel now offers as many as 28 cores in a single processor die. More cores on the same process means fewer CPUs can be extracted from a single wafer, which in turn can constrain supply.

But however you slice it, Intel has not been suffering financially, which is the most important reason why you can expect Intel to respond in terms of product and technology. As for resources, Intel retains a huge advantage over its only rival in the PC processor market, AMD.

That response has already started to show. Ice Lake debuted Intel's first new CPU core architecture since Skylake, known as Sunny Cove. It delivers performance-per-clock improvements of around 18 percent over the Coffee Lake revision of the Skylake architecture.

But that's just the beginning. Central to Intel's architectural resurgence was the addition of Jim Keller, heading up Intel's CPU development team. Although he's departing in the next six months, it's hard to disregard what his experience may bring. Keller is one of, if not the most, highly regarded processor architects in the business. He made his name as lead architect of AMD's K8 technology, the chip otherwise known as the Athlon 64, and the first CPU from AMD that really took the fight to Intel. Keller later worked for Apple, kick-starting the series of in-house ARM-based processor designs that have dominated the smartphone and tablet segments. In 2012, Keller returned to AMD, driving the development of Zen and once





By the time Intel has fully fixed its 10nm wafers, it's likely that 7nm production will have started.

again giving AMD the tools to fight Intel. After a brief stint at EV maker Tesla, Keller arrived at Intel in April 2018.

Given the lead times between the initial design and conception of a CPU architecture and its inclusion in products available to buy, it's very unlikely that the new Sunny Cove cores inside Ice Lake processors are Keller's work. The same is likely true of the follow-up to Sunny Cove, known as Willow Cove, which may appear later this year in the Rocket Lake family of 14nm "backport" CPUs and is not thought to be a major advance on Sunny Cove.

Next up is Golden Cove, which will be a bigger step forward late next year when it forms the basis of Intel's upcoming Alder Lake CPUs. But even Golden Cove probably isn't what you might call a pure "Keller" processor. For that we'll have to wait for 2022 or 2023 and Ocean Cove, although his impending departure from Intel will mean his influence on even this project will likely be somewhat reduced.

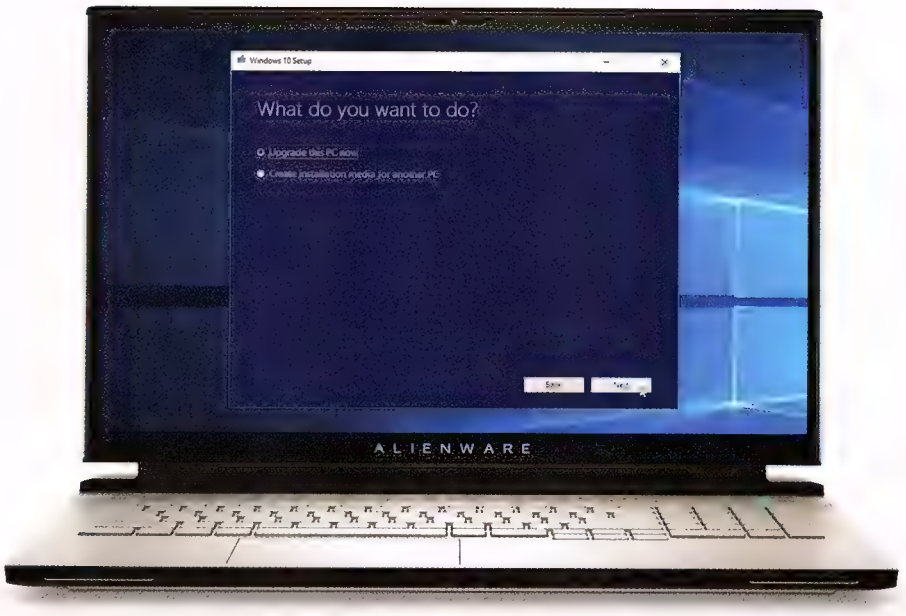
Almost nothing official is known about Ocean Cove. Recently, rumors emerged indicating that Ocean Cove could deliver as much as 80 percent more performance per clock than Skylake. For now, that is speculation. All we know for sure is that Keller has an outstanding track record and that Intel's roadmap is more aggressive now than it has been for many years. As Keller himself has said, "We have a roadmap to 50 times more transistors and huge steps to make on every single piece of the stack."

Meanwhile, the follow-up to the troubled 10nm node, Intel's upcoming 7nm process, doesn't face the same limitations as 10nm. For 7nm, Intel is transitioning to extreme ultraviolet lithography (EUV) with wavelengths as small as 13.5nm. 7nm, in other words, is a fundamental reset. Time will tell, but Intel is certainly making bullish predictions for 7nm and beyond.

Intel plans more overlap between its upcoming nodes, including 7nm, 5nm, and the processes that follow. That means pressing on with new technology as opposed to milking nodes for every last cent, even if that comes at an R&D cost. "In order to regain process leadership, we had to accelerate the overlap between 10nm and then 7nm and 5nm. Starting particularly in 2021, the performance of 10nm will intersect with investment in 7nm, and we're also willing to start an investment in 5nm, all of those elements combined," says Intel CFO George Davis.

In fact, Intel expects to return to a two-year release cadence based on the new EUV era, starting with 7nm late next year and extending all the way to the release of the 1.4nm node in 2029. "I think EUV will give us back a degree of the traditional Moore's Law cadence," says Davis.

Taken together, it paints a picture of Intel reverting to the norm of creating the most advanced processor architectures and the world's fastest CPUs. Whether that happens is another matter. AMD is arguably in a better position now than ever before to maintain the pressure, even if Intel significantly ups its game. AMD's architecture roadmap, including the likes of Zen 3 and Zen 4, combined with TSMC's manufacturing prowess, will make for stiff competition. But we'll not be betting against Intel. After all, the last time Intel stumbled, back in the dying days of NetBurst and the Pentium 4, its response was the Core dynasty and a decade-long domination of the CPU market.



Windows 10 users can launch a repair install directly from the Media Creation Tool.

FEATURE

REPAIR A WINDOWS INSTALL

If you're trying to fix a problem, a refresh or repair install may be the best route to go down. Here's what you need to do...

Not all reinstalls require a complete wipe of your hard drive. A repair or refresh installation leaves your programs, settings and files in place, and restricts itself to installing a fresh copy of your Windows files over the top of your existing copy. If your problem is linked to a corrupt file or Windows setting, the repair installation can usually fix it.

All repair installs share one common characteristic: you must launch them from Windows itself. You can't boot from your install media and repair Windows through that; you need to boot into Windows, then start the repair process from there. If you're unable to boot into Windows, therefore, you'll need to perform a full destructive recovery instead.

Start the repair

Starting a repair install varies depending on your PC model and what version of Windows you're running. Windows 8.1 and 10 users should (at least initially) avoid the Refresh/Reset options provided under Settings > 'Update & recovery'. These options will preserve your files and any apps you've installed through the Microsoft Store, but any desktop programs you've installed will be wiped along with Windows itself.

Instead, you should 'upgrade' your copy of Windows, which performs a similar non-destructive reinstall to Refresh/Reset with the added bonus that your apps – including those you've installed outside of the Microsoft Store – will be preserved. To do so, you'll need your Windows installation media – see the step-by-step guide on the facing page if you don't have the latest version.

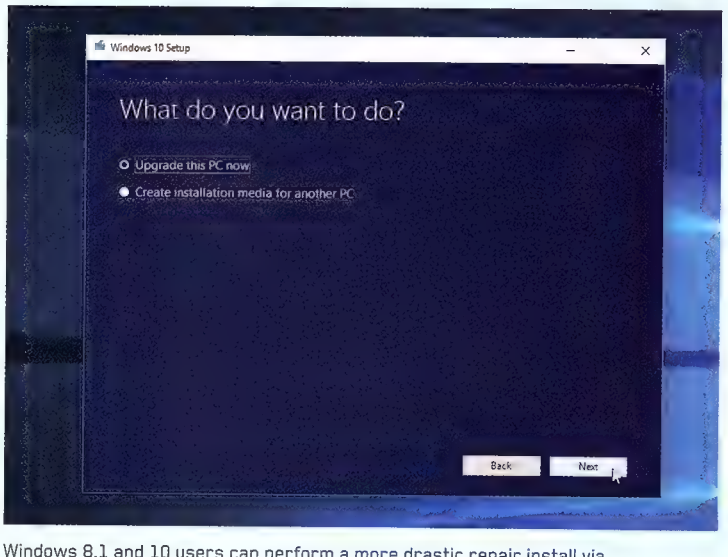
Why do you need the latest install media? It's because upgrade installs only work if the version of Windows on your

Post-repair steps

Start by stress-testing your desktop to verify that everything works as it should – sometimes the repair can introduce more problems than it solves, in which case if you're running Windows 8.1 or 10 you can undo the changes. Go to Start > Settings > 'Update & recovery' > Recovery and look for an option to go back to your previous version – click 'Get started' and then follow the prompts.

If the repair doesn't appear to fix your underlying problem, Windows 8.1 and 10 users can take one more intermediate step – the reset or repair. It will see you waving goodbye to all those desktop programs you've installed (including MS Office and your third-party security software), but it will preserve your Microsoft Store apps, files and Windows settings. Leave your install media inserted, then head over to the 'Update & recovery' > Recovery section under Settings. This time, click the 'Get started' button under the Refresh (Windows 8.1) or Reset (Windows 10) option and follow the prompts.

If this more drastic approach doesn't work, or you're running Windows 7, then to page 70 for destructive reinstall options.



Windows 8.1 and 10 users can perform a more drastic repair install via the Reset or Refresh option – be warned, you'll lose your desktop apps.

PC matches that on your install media, so if you've installed Service Pack 1 in Windows 7, for example, you need up-to-date installation media to avoid the laborious task of first attempting to uninstall Service Pack 1 through Windows Update (assuming that you're able to), then reinstalling Windows and then downloading and reinstalling Service Pack 1, along with all of your other updates.

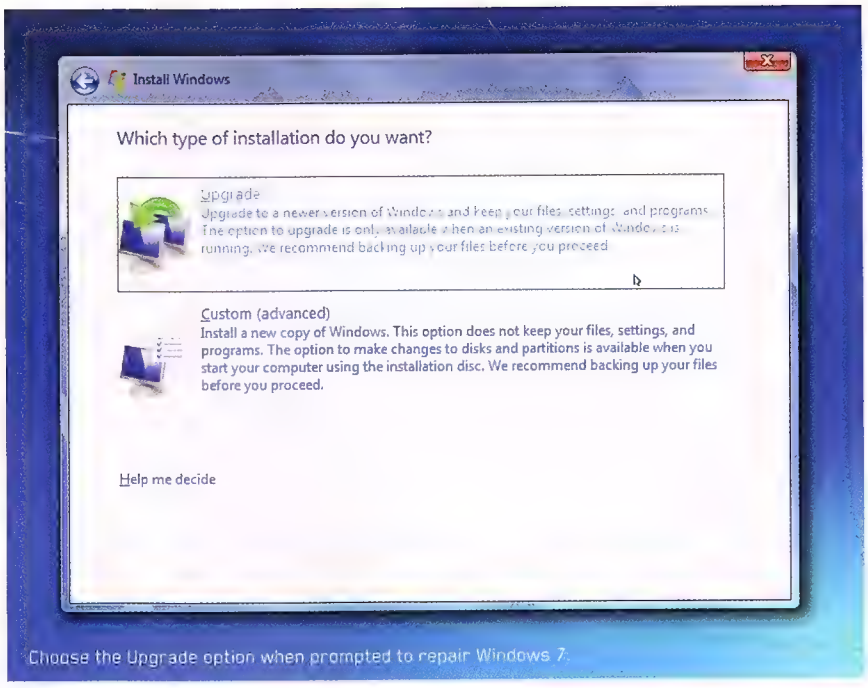
Windows 10 users can also launch the repair process directly from the Media Creation Tool by choosing Upgrade when prompted, but given the amount of time it takes to download the files, you might as well create your install media instead – just in case the upgrade install doesn't work and you decide to go down the path of a full-blown destructive install.

Launch the repair process

The procedure from this point onwards varies according to which version of Windows that you have. If prompted to download updates, do so to save time post-install.

Windows 8.1 and 10 users will be asked what they want to keep. Windows 8.1 users should find settings, personal files and applications are selected by default (click 'Change settings' if this isn't the case), while it's 'Keep personal files and apps' in the case of Windows 10 (don't worry, in this circumstance, 'apps' also applies to any desktop programs that you have installed).

Windows 7 users need to pop in their install media, double-click setup.exe and follow the regular reinstall process. When prompted, click 'Go online to get the latest updates for installation (recommended)' to download post-SP1 security fixes now, then accept the licence agreement and choose Upgrade when prompted.

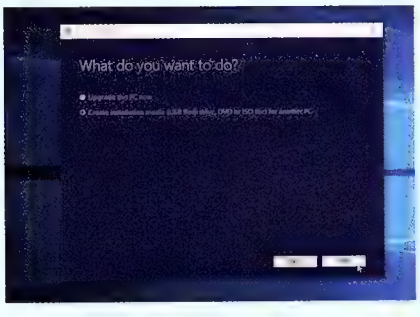

Install Windows
Which type of installation do you want?
Upgrade
Upgrade to a newer version of Windows and keep your files, settings, and programs. The option to upgrade is only available when an existing version of Windows is running. We recommend backing up your files before you proceed.
Custom (advanced)
Install a new copy of Windows. This option does not keep your files, settings, and programs. The option to make changes to disks and partitions is available when you start your computer using the installation disc. We recommend backing up your files before you proceed.
Help me decide
Choose the Upgrade option when prompted to repair Windows 7.

The upgrade process can take up to an hour on whichever version of Windows you're repairing, even on the fastest machine, so be patient. Your PC will reboot several times. If you're reinstalling Windows 7, you'll be prompted to enter your product key again, so have it handy.

Windows 8.1 and 10 will relaunch with the same setup wizard you'd see when upgrading from an earlier version of Windows. It's all very straightforward, but don't skip through the Express settings (if they appear); make sure you review all settings to lock down privacy.

If all goes well, you should find yourself at the desktop, ready to see if your problem has been fixed – start by seeing if the specific issue that you were experiencing before has been solved, then check to see that the rest of Windows still works as it should – if it's not, follow the advice in the 'Post-repair steps' box on the facing page. There's also a possibility – particularly with Windows 7 – that the repair install will result in a non-booting PC. If this happens, dig out the rescue media you created using Macrium Reflect Free and use it to restore the drive image you took before embarking on the repair. Then turn the page for more options.

HOW TO Get the latest install media



01 WINDOWS 10
Head to **www.microsoft.com/software-download/windows10** and click 'Download tool now'. Once downloaded, open MediaCreationTool.exe. When prompted, select 'Create installation media' and follow the prompts to create either a USB flash drive or an ISO file (for burning to DVD).

02 WINDOWS 8.1
Download the Media Creation Tool from **www.microsoft.com/software-download/windows8** – input your language, edition of Windows 8.1 and PC architecture (32-bit or 64-bit) and then click Next. Choose to create either a USB flash drive or an ISO file and then follow the prompts to the end.

03 WINDOWS 7
Go to **www.microsoft.com/software-download/windows7** and enter your product key – choose a 32-bit or 64-bit version as required. Once downloaded, double-click the file to burn to DVD, or use the Windows USB Download Tool (**https://wudt.codeplex.com**) to create a USB flash drive.

A full, destructive reinstall

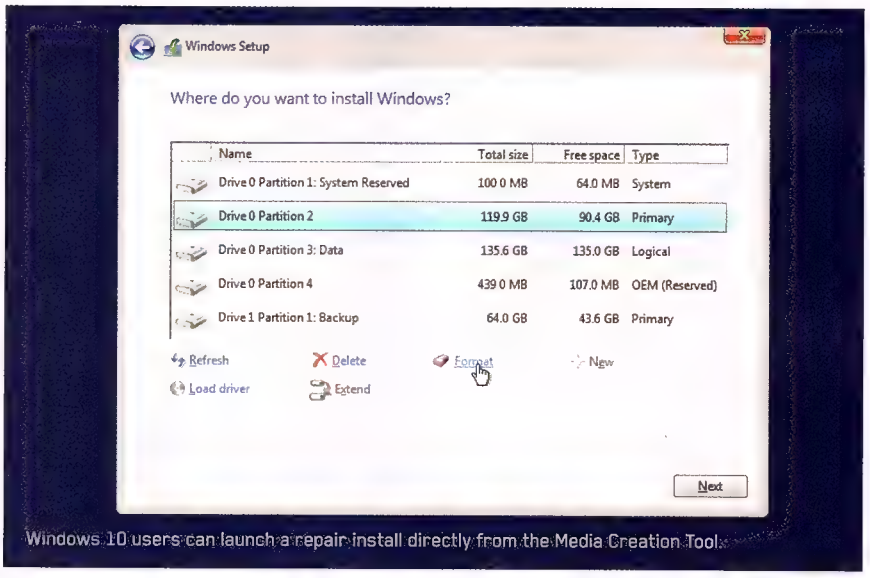
If you're looking to wipe the slate clean, or need to recover from major issues, the nuclear option is always the best one.

Reinstalling Windows from scratch – namely, wiping your system drive to install a fresh version of Windows on to it – is the ultimate choice for anyone looking to revive a slow PC or resolve a major, non-hardware issue. Here we'll step you through the entire process.

Before you begin, make sure your PC is fully backed up. A full reinstall really is destructive – nothing left on your C drive will exist once you've finished.

If you'd like to transfer selected program settings from old installation to new, download the portable CloneApp tool (**www.mirinsoft.com**) to your backup drive. Once complete launch the tool by right-clicking CloneApp.exe and choosing 'Run as administrator' and go through its list of 247 supported apps to see if yours are there. If any are, tick the box beside each one you want to save the settings for. If any apps aren't covered – or you want to back up additional settings – then choose Custom where you manually specify the files, folders and Registry keys where your program settings are stored. You should also follow the step-by-step guide included to ensure you have the latest installation media for your target version of Windows. This will ensure a cleaner, more up-to-date installation from the off.

It's also worth sourcing networking and graphics drivers now rather than relying on Windows. Consult your PC or motherboard manufacturer's website for these, or visit your Wi-Fi adapter or graphics card manufacturer's site – download them to your backup drive.



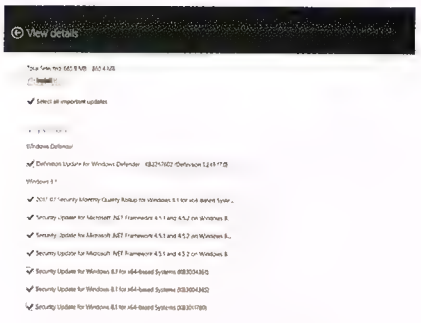
Windows 10 users can launch a repair install directly from the Media Creation Tool.

Uninstall any products that require activation – this should deactivate the licences and allow you to use them with your new install. Be sure to have product keys and program installers to hand.

Start your reinstall

A full destructive reinstall should always be started by booting from your installation media, be it a DVD or USB flash drive. Check the step-by-step guide on page 70 for some pointers.

The reinstall process doesn't differ



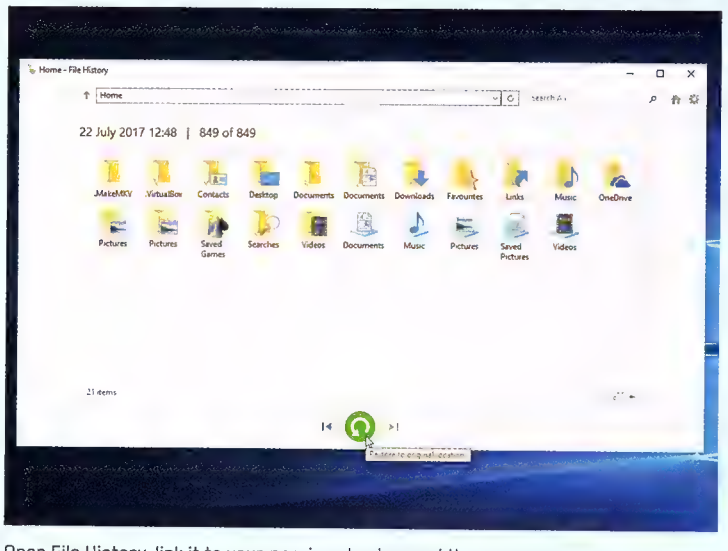
Windows 7 and 8.1 users will find a large number of updates waiting to be installed after reinstalling.

Restore programs, settings and data

Once Windows is reinstalled, open Windows Update to bring Windows fully up to date – don't be surprised if there are hundreds of updates still to apply in the case of Windows 7 and 8.1. Once it's fully up to date, consider reinstalling Macrium Reflect Free and taking your first drive image – a vanilla backup you can restore in future instead of reinstalling Windows itself.

Next, it's a case of reinstalling your core apps. Once in place, open CloneApp from your data drive. If you click the Restore button, every single program setting you backed up will be restored – if there are any backup settings you don't want to restore, select Options to locate the backup folder, then open it and move any program folders you want to ignore out of the folder temporarily before clicking the Restore button. Now, take your second Macrium Reflect backup – a 'perfect' snapshot, as it were.

Finally, open File History or the Windows Backup and Restore tool and take steps to restore any data you backed up, then make sure the tool is configured to carry on backing up going forward.



Open File History, link it to your previous backup and then you can restore all your data back to its original location with one click.

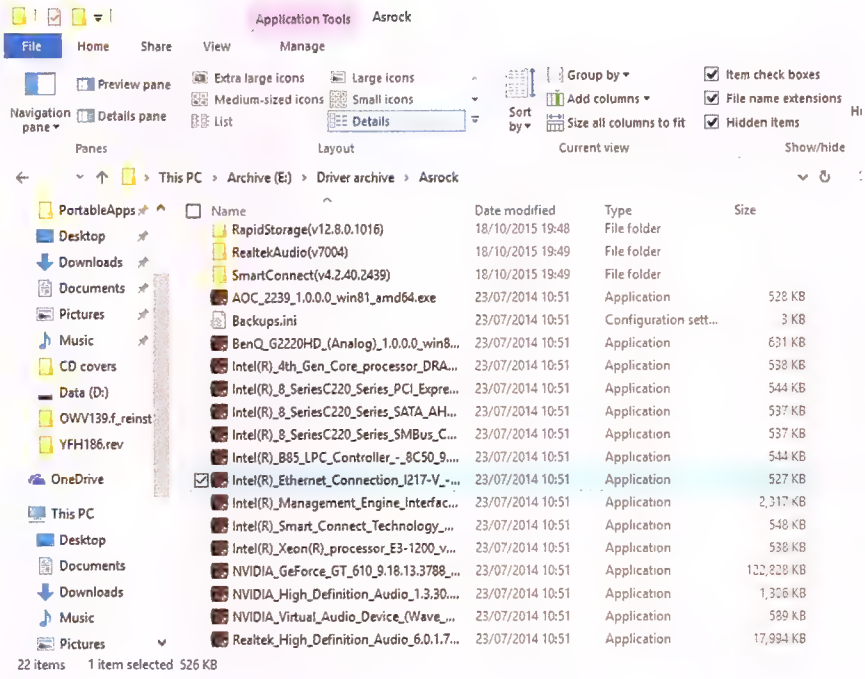
much across Windows 7, 8.1 or 10. You'll be asked to verify your language, location and keyboard are set correctly, then it's a case of clicking Install Now. If prompted, enter your product key or click Skip if you're running Windows 10 on a PC you upgraded during the free period. When asked what type of installation you wish to perform, choose the Custom option.

Next comes the trickiest part of the process. A list of drives and partitions will appear – you need to select the one Windows is currently installed on. By default, it should be detected and selected, but verify it's correct before clicking Format (click the advanced Drive Options button if it's not visible). Click 'OK', then once formatted, verify the drive is still selected and click Next. You'll see a checklist of tasks to be performed – sit back and wait. When Windows reboots, you may a 'press any key' prompt to boot from CD or DVD. Ignore and let the installer continue.

Set up post-install

The post-setup prompt begins with Windows 7 users being prompted for their product key, then it's a case of setting up a user account. Windows 8.1 users will get an Express Settings prompt – click the option to customise these and go through them carefully.

Post-Creators Update, Windows 10 no longer gives you an Express Settings option. For now, confirm your location and keyboard, set up your network if required and choose 'personal use' when prompted. You can either sign in with your Microsoft account or click 'Offline account' > 'Maybe later' if you plan to stick with the old-style Windows 7 local user account. If you opt for the Microsoft account option now is a good time to set up a PIN to speed up future logins (note: the PIN is tied specifically to this PC, and you can always bypass it using your regular account password should you forget it at any point). You'll then be asked to set up Cortana – this is where Windows 10's notorious privacy settings come into play, so review all of the options carefully, flicking the slider to Off for any you don't need or use.

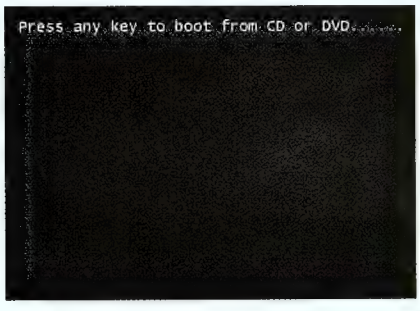


Make sure you've got network and graphics drivers sourced.

"Next comes potentially the trickiest part of the process. A list of drives and partitions will appear – you need to select the one Windows is currently installed on."

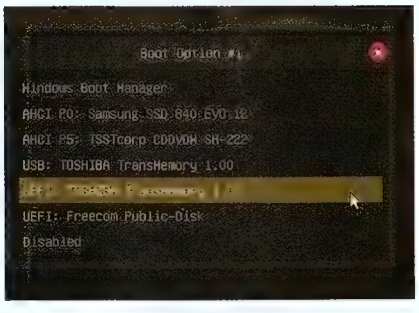
That's the end of the setup process – Windows will configure itself based on your choices and you'll see a series of messages appear on-screen. When all is ready, you'll find yourself back at the familiar Windows desktop screen of a fresher, faster, smoother-running PC.

HOW TO Start the install process



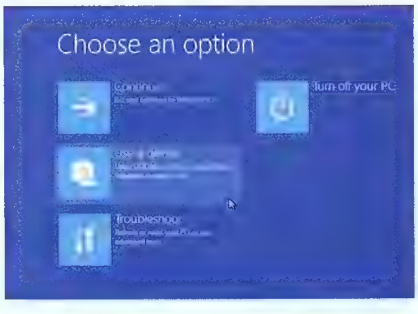
01 REBOOT FOR MEDIA

If you're running Windows 7, or have Fast Boot disabled, insert your boot media and start your PC. Look for a 'Press any key to boot from CD or DVD' option (even if you've booted from a USB flash drive) – press the key and you should find the Windows install process starts.



02 TWEAK BOOT OPTIONS

If you boot back into Windows, restart your PC again, but this time press a key, such as [F11], when prompted to open a boot menu. Do so, select your boot media (choose UEFI if the option appears) to boot; otherwise, enter Setup to change the boot device order.



03 WINDOWS 8.1/10

If Fast Boot is enabled, open Settings in Windows and navigate to 'Update & recovery' > Recovery, then click 'Restart now' under 'Advanced start-up'. When the boot options appear, choose 'Use a device' to select your USB flash drive or DVD from the list.

Other reinstall options

Get the lowdown on three further techniques: reinstall from a recovery partition, downgrade Windows and set up a dual-boot system.

So far, we've covered both traditional reinstall techniques, but there are other reasons – and methods – for reinstalling Windows. First up is the recovery option. Most pre-built PCs come with a built-in manufacturer's recovery partition that enables you to restore Windows to its factory shipped condition. The main advantage of this method – aside from being cheaper and easier for the manufacturer, of course – is that your PC is restored to a guaranteed working state, with all the drivers it needs to function. The downsides are that a lot of extra unwanted software is usually installed alongside Windows, you need to exercise extreme caution not to lose everything on the drive, and that if the recovery partition corrupts – typically due to hardware failure – you're left with no means of reinstalling Windows.

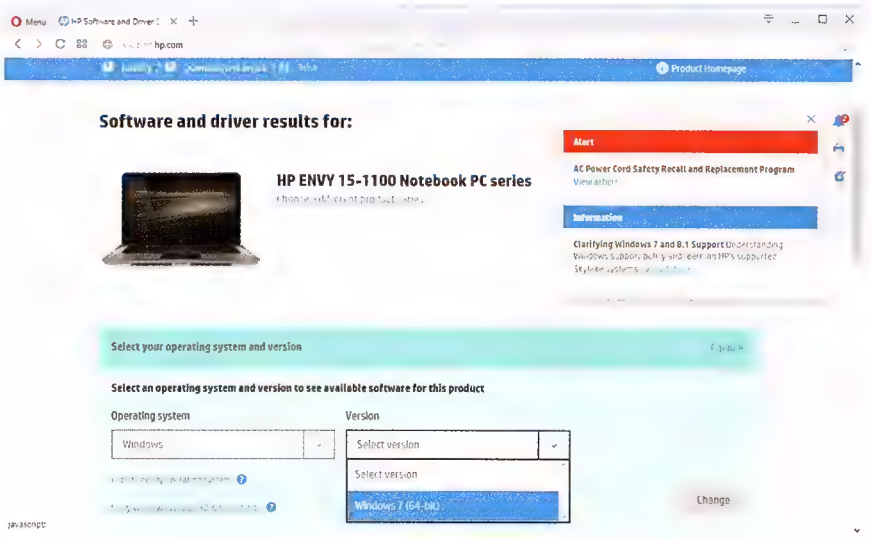
If you're planning to reinstall Windows by this method, look for a prompt to start recovery when you first boot Windows or look for the option under the 'Advanced start-up' menu (see below) – consult your computer's documentation or manufacturer's website for details. Remember that most recovery options are fully destructive, so be sure to have backed up your system before you begin – and that includes creating a complete drive image.

Downgrade Windows

Another reason to reinstall Windows is to revert to an earlier version. If you're pining for Windows 7 or 8.1, then it's usually possible to downgrade your copy of Windows – remember support for Windows 7 ended in January 2020, and Windows 8.1 in January 2023. Before reaching for your old Windows media, however, you need to do some homework first.

First, if you upgraded your PC to Windows 10 from an older version of Windows, restoring that version should be straightforward in the sense you can use your manufacturer's recovery partition if it still holds the original version, or you can try installing from an old, unused copy of Windows 7 or 8.1 – just follow the guides to preparing and reinstalling Windows earlier on in this feature. Do source the correct drivers for your PC first, though, and verify that your new software is backwards compatible (desktop apps should be, but Microsoft Store apps won't work in Windows 7, and some may not work in Windows 8.1 either).

Look under the 'Advanced start-up' menu for factory restore options.



Fetch the drivers for whichever version of Windows you install.

"If you're pining for Windows 7 or 8.1, it's usually possible to downgrade your copy of Windows – remember support for Windows 7 ended in January 2020, and Windows 8.1 in January 2023."

If your PC came with Windows 8.1 or 10 preinstalled, then going back to Windows 7 will be trickier and possibly even impossible. Before embarking on this, check the web to see if others have had similar success. You'll need to source your own Windows 7 installation media and valid licence, and you'll almost certainly need to have access to your PC's UEFI settings – if Fast Boot is enabled, open Settings > 'Update & recovery' and click 'Restart now' under 'Advanced start-up'. When prompted, select Troubleshoot > Advanced Options > UEFI Firmware Settings.

Once inside your PC's UEFI settings you need to locate and change three settings. First, disable the Fast Boot feature. Second, disable Secure Boot. And finally, look for a CSM (Compatibility Support Module) option and make sure it's enabled. All three settings need to be made to support Windows 7 – if you can't find them, consult with your PC or motherboard manufacturer.

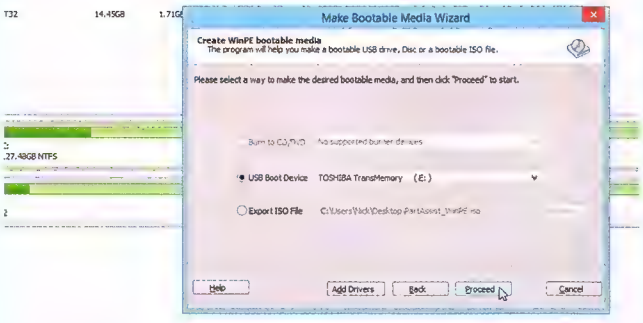
Once done, you should find you're able to boot from your Windows 7 installation media, enabling you to revert to the earlier copy of Windows.

Set up a dual-boot PC

Our final scenario is one where you install two versions of Windows side-by-side. This is a step for advanced users only, and if you're merely planning to install an older version of Windows next to Windows 10 for compatibility purposes, explore alternative options, namely setting up a virtual Windows 7 machine using a tool such as VirtualBox (**www.virtualbox.org**), which runs inside your main Windows installation.

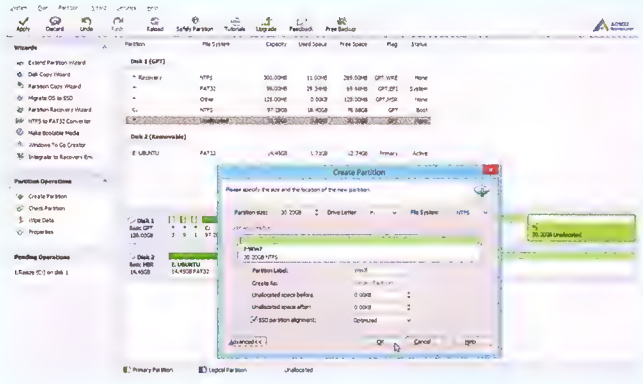
If you are determined to dual-boot your setup, the step-by-step guide on the facing page covers the process of installing an older version of Windows alongside your current one.

Before you begin also make sure you take a fail-safe drive image using Macrium Reflect Free and be sure to create the rescue media, too.


Make Bootable Media Wizard
Create WinPE bootable media
The program will help you make a bootable USB drive, Disc or a bootable ISO file.
Please select a way to make the desired bootable media, and then click "Proceed" to start.
USB Boot Device
TOSHIBA TransMemory (E:)
Export ISO File
Help
Add Drivers
Back
Proceed
Cancel

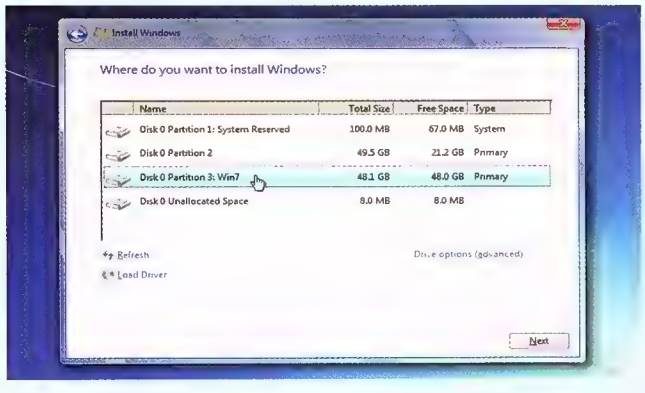
02 PARTITION HARD DRIVE

You'll need to partition your drive to free up space on which to store your copy of Windows. The best tool for the job is AOMEI Partition Assistant (**www.aomeitech.com/aomei-partition-assistant.html**). Start by clicking Make Bootable Media under Wizards to create rescue media.



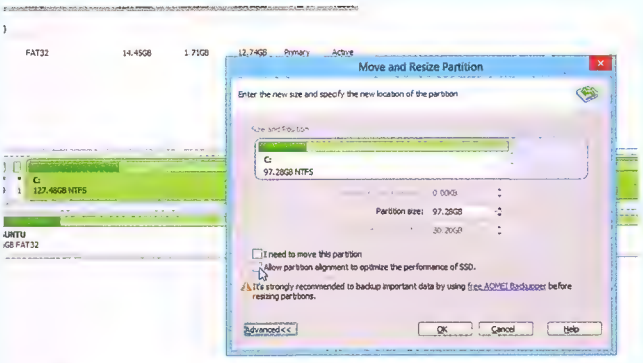
02 ADD NEW WINDOWS PARTITION

Now select the newly created Unallocated space to the right of drive C and click 'Create Partition' under Partition Operations. Verify NTFS is the file system and click 'Advanced <<' to give the partition a suitably descriptive label, such as Win7 before clicking OK. Click 'Apply' > Proceed and reboot.



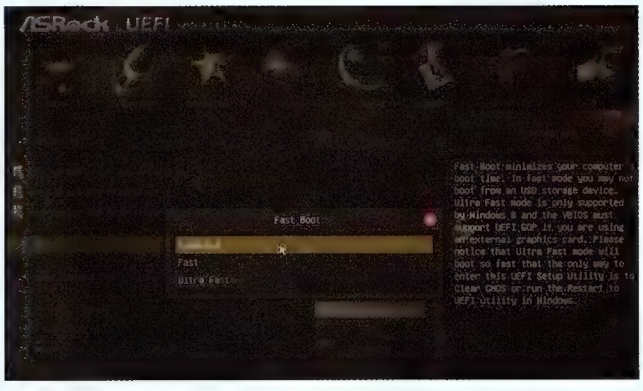
02 INSTALL NEW COPY OF WINDOWS

Once the new partition has been created (check in Windows), reboot using the installation media for your target version of Windows. The install process is almost the same as for a regular Windows installation, but be sure to choose the newly created partition as your target during installation.


Move and Resize Partition
Enter the new size and specify the new location of the partition
C:
97.28GB NTFS
Partition size:
97.28GB
I need to move this partition
Allow partition alignment to optimize the performance of SSD.
It's strongly recommended to backup important data by using free AOMEI Backupper before resizing partitions.
Advanced<<
OK
Cancel
Help

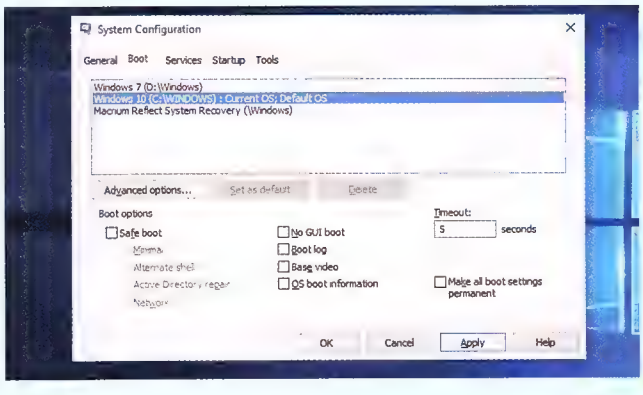
02 SHRINK MAIN PARTITION

Select your Windows drive (typically C:) and click Resize/Move Partition under Partition Operations. Use the slider to free up at least 30GB space to the right of the Windows partition. If your drive is an SSD, click 'Advanced >>' and tick 'Allow partition alignment…' Click 'OK'.



02 TWEAK UEFI SETTINGS

If installing Windows 7 alongside Windows 8.1 or 10, you may need to reboot into your UEFI (see the main text) to enable the Compatibility Support Module (CSM), plus disable Fast Boot and Secure Boot. Once done, you should be able to boot successfully from your Windows 7 installation media.



02 POST-INSTALL STEPS

When Windows reboots for the first time you'll see a boot menu appear listing the different versions of Windows you have installed. If the 30-second delay is too long, or you want to change the default, Click 'Start' > Run, type msconfig and press Enter, then make changes from the Boot tab. ■

System News

Mark Williams takes another look at how the PC industry is coping with the continued demands due to the coronavirus.

As COVID-19 continues to affect our daily lives, so too does it continue to impact PC retailers, shops, and supply chains. At the beginning of last month, I placed an order at a large PC retailer. It was a couple thousand dollars worth of equipment for the company I work for. Nothing exotic or out of the ordinary, simply common PC components like CPUs and memory and SSDs, right through to monitor cables. All things that, according to their website, were available and in stock at the time.

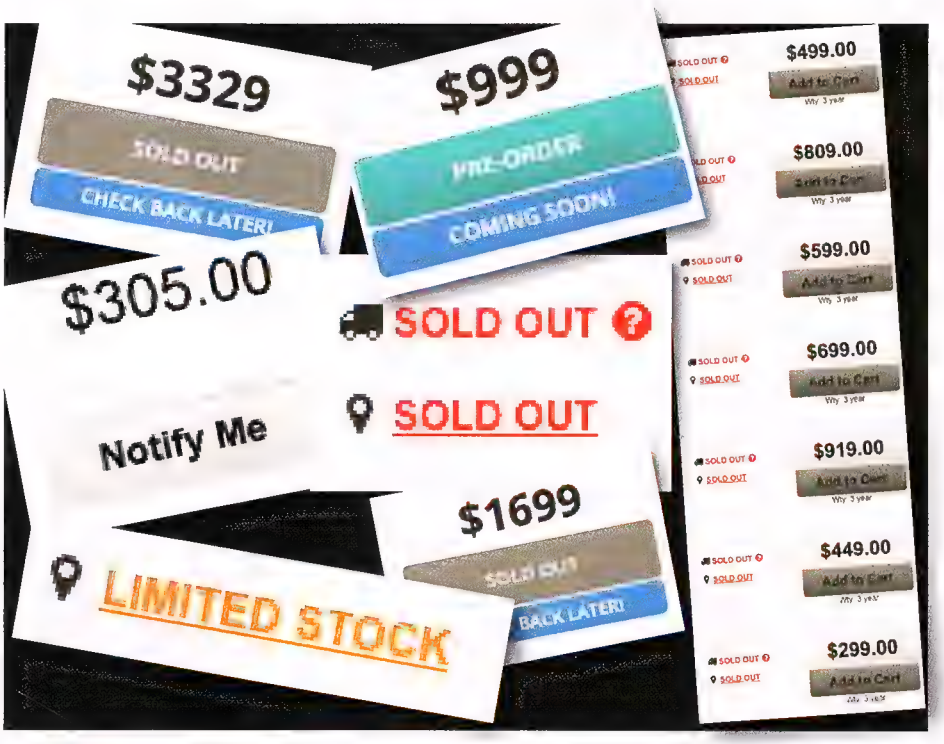
Now, given the size of the order I was expecting it might take 3-4 days to pick everything and get it shipped out, but as time ticked by after a week only about half the items had been allocated to my order. It was not until 12-14 days after placing the order did everything finally get allocated and shipped out!

Not only is this an indicator of just how busy the PC industry is from the increased demand due to the COVID-19-related sales spike, but Jaimie from Leader Computers also mentions that those places will be having a hard time sourcing parts and maintaining stock levels due to the lack of international freight flights to keep themselves stocked.

In fact, air freight has become so cost prohibitive due to the huge decline in the numbers of flights – not to mention horribly unreliable or irregular – that they're having to switch to "sea freight on gear [which] has added a good two weeks to lead times across the smaller items such as RAM and SSDs for example. Airfreight at one stage was six times the normal cost, people were paying $18k to ship one Pallet via air, normally around $3k!"

Jaimie goes on to mention that much of the demand has shifted away from the fundamental stuff like PC systems/laptops and monitors that were in high demand at the beginning of the COVID-19 working from home boom, to more networking capacity upgrades and security devices like routers, and VPN-capable switching gear.

And while that may well be true, shortages are still persisting for system parts.



MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

A couple of weeks ago, I noticed most X570 motherboards were out of stock or hard to come by. This seems to have been resolved at the time of writing, but now Threadripper and Intel 10th Gen CPUs and TRX40 motherboards are in short supply.

The shortages and unreliable stock levels seems to have even taken a toll on Scorptec's pre-built PC systems line-up with less than 30% of their range being available to order, and even then, only in limited quantities.

While the high demand remains along with the strained supply channels, Jaimie seems confident that we won't see demand like we had back in March, with the initial surge of the working from home paradigm shift the economy was forced to take, but demand will remain elevated for quite some time as "many businesses shift to a more flexible work platform allowing work from home for certain roles, as it can reduce their overheads significantly in other areas such as commercial real estate and power etc. This may drive a strong wave of investment over the next quarter."

Shop Talk

JAIMIE, LEADER COMPUTERS:

"The continuing COVID-19 situation is still putting strain on the supply chains we rely on as many of our vendors are not at full manufacturing capacity and Australia is getting small allocations. Also, the lack of international flights makes airfreight very cost prohibitive and unpredictable, so sea freight is the only reliable way to get stock.

Most people and companies have sorted their base gear for work from home, where the market has shifted now is fixing all the networking and security holes that work from home has opened up, so lots of VPN-capable routers, UTM appliances and other networking infrastructure. The government stimulus to companies has meant that spending has remained strong at this stage, with some major projects taking advantage of the continued stimulus going through till the end of December."

Market snapshot

A sampling of PC systems available this month.

$2,921 | preview.tinyurl.com/APC484PLE

PLE Computers Hawk

Out of the box this system appears to be set up for high FPS gamers aiming at 1080p resolutions. While certainly capable of 1440p, the CPU is the more powerful of this CPU/GPU pairing and so would lend itself best to lower resolution higher FPS use cases like eSports and competitive titles. Oddly, despite the expensive motherboard choice the CPU included is not unlocked and thus is money wasted. For $10 more at checkout we'd recommend the i5 10600KF to get the most out of the expensive motherboard investment. The high airflow case will be great for system temps and the 750W PSU gives plenty of headroom for future upgrades.

CPU: Intel Core i5 10600, **COOLER:** Cooler Master MasterAir MA620P RGB, **MOTHERBOARD:** Asus TUF Z490-PLUS WiFi, **GRAPHICS:** Zotac Gaming GeForce RTX2060, **MEMORY:** GeIL16GB DDR4 3000MHz, **STORAGE:** Seagate FireCuda 510 500GB NVMe SSD, Seagate Barracuda 1TB HDD, **POWER SUPPLY:** eVGA Supernova G1+ 750W, **CASE:** Cooler Master MasterCase H500P

$2,599 | tinyurl.com/APC484PCC

PC Case Gear Fusion 2070 Super

Coming in cheaper than the PLE Hawk system, this rig is set up more for gaming at 1440p with high detail game settings. While certainly capable of 1080p high fps gaming, the CPU will hold you back on that front relative to Intel's 10th gen. The graphics card is more powerful here and so graphical details can be ramped up to reduce CPU bottlenecking, thus getting the most out of the system. The 3200MHz RAM is ok, but Ryzen likes 3600MHz best. A missed opportunity. The 256GB SSD is speedy but feels a little on the small side in this price category. Ditching the HDD and upgrading to a 500GB+ SSD would generally have been the better choice.

CPU: AMD Ryzen 5 3600, **COOLER:** OEM, **MOTHERBOARD:** MSI B450M Mortar Max, **GRAPHICS**: MSI GeForce RTX 2070 Super Ventus GP OC 8GB, **MEMORY:** Corsair Vengeance RGB Pro 16GB 3200MHz CL16 DDR4, **STORAGE:** Adata XPG SX8200 Pro M.2 NVMe SSD 256GB, Seagate Barracuda 2TB HDD, **POWER SUPPLY:** Super Flower Leadex III Gold 650W, **CASE:** Phanteks Eclipse P400A

$2,849 | tinyurl.com/APC484SCP

Scorptec Computers Lucent RTX 2070 Super

Relative to the PCCG Fusion system, this costs $250 more which nets you two extra CPU cores and double the SSD capacity, but slightly slower RAM speeds. Gaming-wise this system will perform about the same. The difference will be in productivity applications that can utilise the extra cores. High airflow cases are making a comeback and the Cooler Master MasterBox TD500 is one of the new designs based on this philosophy. Expect good thermals particularly on the GPU as a result. Upgrading to 3600MHz RAM when ordering would be something worth looking into to extract the most performance from the CPU and would only cost an extra $10.

CPU: AMD Ryzen 7 3700X, **COOLER:** OEM, **MOTHERBOARD:** MSI Gaming B450 Pro Carbon Max WiFi, **GRAPHICS:** MSI Gaming X Trio GeForce RTX 2070 Super 8GB, **MEMORY:** Corsair Vengeance LPX 16GB 3000MHz DDR4, **STORAGE:** WD Blue SN550 500GB M.2 SSD, Seagate BarraCuda 2TB HDD, **POWER SUPPLY:** SilverStone Strider 650W, **CASE:** Cooler Master MasterBox TD500 RGB

$3,299 | tinyurl.com/APC484MWV

Mwave S507i

Stepping up in price from the Scorptec Lucent system, this has a not insignificant $450 price premium on it. This does not get you any improvement in graphics performance, but does get you a much better gaming CPU that clocks over 5GHz which games love, especially for 1080P and 1440P 144Hz+ gaming. The CPU is also superb at productivity and will typically best any AMD 8-core CPU in thread-heavy applications thanks to the matching thread count with higher clock speeds. The included water-cooling allows for good overclocking headroom.

CPU: Intel Core i7 10700K, **COOLER:** Cooler Master MasterLiquid ML240R, **MOTHERBOARD:** Asus TUF Gaming Z490-Plus WI-FI, **GRAPHICS:** Asus GeForce RTX 2070 Super OC 8GB, **MEMORY:** HyperX 16GB DDR4 RGB Gaming Memory up to 3200MHz, **STORAGE:** Crucial P1 1TB NVMe M.2 SSD, Seagate 2TB 7200RPM HDD, **POWER SUPPLY:** Not specified, **CASE:** Fractal Design Define 7 Compact Dark

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

When beans matter.

There's quite the hike on power supply prices this month we're afraid. But in the interest of variety we've got two different options for you, both at 450W: The MWE 450 V2 from Cooler Master in our budget AMD system, and the CX450 from Corsair in its Intel counterpart. The V2 is a bit cheaper, but the CX450 has a better efficiency rating (80+ Bronze vs the V2's 80+ White certification), so it's up to you to decide what you want to spend your money on.

Motherboards proved a pricey problem for our AMD build, where we've had to swap over to the Asus Prime B450M-A, a slightly smaller Micro ATX board than the previous MSI Pro B450M. Bear in mind that if you don't buy the Asus motherboard new, you may need a 2nd-generation AMD CPU in order to flash the BIOS for Ryzen 3000 compatibility. We're not changing much else on the AMD build, though. The 120GB SU650 drive from Adata is still an absolute steal at just $56.

We're shaking things up a bit more over in the Intel machine. First up, the previous motherboard is no longer on sale, so that's gone. Replacing it is another Asus Prime board, the eye-catching Prime Z390-P. We're shaving $120 off the overall price by switching over to EVGA's single-fan GTX 1660 Super Black Gaming, then a few dollars more by changing up the memory for G. Skill's Ripjaws V Series RAM at the same capacity and speed we had before.

We're sticking with the SU650 SSD and Seagate Constellation ES HDD for both builds, as both have dropped in price since our last issue, and together they're pretty much the best budget storage available right now. Neither processor will be changed either for now, but watch this space. With the Intel Core i5-10600K now available, we'll be planning an upgrade to this build soon, but right now those chips are entirely sold out, so we'll have to wait. The 10600K costs a fair bit more than its previous-generation counterpart, and we might need to upgrade the motherboard too.

"Motherboards proved a pricey problem for our AMD build, where we've had to swap over to the Asus Prime B450M-A, a slightly smaller Micro ATX board than the previous MSI Pro B450M."

AMD INGREDIENTS

PART		PRICE
CASE	BITFENIX NOVA TG	$120
PSU	450W COOLER MASTER MWE 450 V2 **NEW**	$69
M/BOARD	ASUS PRIME B450M-A **NEW**	$139
CPU	AMD RYZEN 5 3600	$299
GPU	ASROCK CHALLENGER D RX 5600 XT 6GB	$449
RAM	16GB (2 X 8GB) TEAM T-FORCE VULCAN Z @ 3,000MHZ	$109
SSD	120GB ADATA SU650 2.5" SATA III	$56
HDD	1TB SEAGATE BARRACUDA HDD	$70
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	$0
PRICE:		$1,311

INTEL INGREDIENTS

PART		PRICE
CASE	BITFENIX NOVA TG	$120
PSU	450W CORSAIR CX450 **NEW**	$79
M/BOARD	ASUS PRIME Z390-P **NEW**	$245
CPU	INTEL CORE I5-9600K	$210
GPU	EVGA GEFORCE GTX 1660 SUPER BLACK GAMING 6GB NEW	$379
RAM	16GB (2 X 8GB) G.SKILL RIPJAWS V SERIES @ 2,400MHZ **NEW**	$129
SSD	120GB ADATA SU650 2.5" SATA III	$56
HDD	1TB SEAGATE BARRACUDA HDD	$70
OS	UBUNTU DESKTOP LINUX 18.04 LTS 64-BIT	$0
PRICE:		$1,288

"We're sticking with the RTX 2060 for now (with a possible upgrade to a 2060 Super, but we'll look at upgrading the CPU first), switching to EVGA's twin-fan KO Ultra Gaming model."

PC BUILDER

Mid-range

Packing some punch.

Another month, another price drop on the Ryzen 7 3700X. It's one of the best-value processors right now, packing 16 threads, PCIe 4.0 support, and a pretty respectable Wraith Prism RGB cooler. We're not using that cooler here, though: Instead, we're sticking with the Corsair A500, which is $10 cheaper than last month. The MSI Radeon RX 5700 is the best-value 5700 model on the market, and it saves us another $50 from last month thanks to a price drop.

We've taken our savings and decided to upgrade the memory, opting for a twin-stick Corsair Vengeance LPX kit. This has the same memory capacity and frequency as the Vulcan Z RAM it replaces, but thanks to a lower CAS latency we should see an improvement in real-world memory speed. We're sticking with the same drives though, as the Corsair Force MP600 remains the most affordable of the limited selection of PCIe 4.0 drives available. Hopefully we'll see more super-speedy SSDs once Ryzen 4000 chips arrive, although rumors of delays are circulating.

We're changing the PSU across both mid-range builds to the Corsair CX650, which should provide plenty of power for those power-hungry GPUs. On the Intel machine, we're changing out a few more components. We've upgraded the motherboard to the Asus ROG Strix Z390-F Gaming, a more robust board that includes a solid integrated heat sink for our WD Black SN750 M.2 drive.

While we've hung onto the Corsair A500 in our AMD system, we've saved a lot on the Intel CPU cooler with the eminently affordable Phanteks PH-TC14PE. It's pretty much the biggest saving we can make without sacrificing a CPU fan. The last change we've made is a GPU swap. We're sticking with the RTX 2060 for now (with a possible upgrade to a 2060 Super, but we'll look at upgrading the CPU first), switching to EVGA's twin-fan KO Ultra Gaming model. This won't provide much performance boost, but our previous GPU is no longer on sale, making this a better value proposition.

AMD INGREDIENTS

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	$189
PSU	650W CORSAIR CX650 **NEW**	$139
M/BOARD	GIGABYTE X570 GAMING X **NEW**	$329
CPU	RYZEN 7 3700X	$579
COOLER	CORSAIR A500 DUAL FAN	$149
GPU	MSI RADEON RX 5700 8GB	$649
RAM	16GB (2 X 8GB) CORSAIR VENGEANCE LPX @ 3,000MHZ **NEW**	$129
SSD	500GB CORSAIR FORCE MP600	$225
HDD	1TB SEAGATE BARRACUDA HDD	$70
OS	WINDOWS 10 HOME 64-BIT OEM	$140
PRICE:		$2,598

INTEL INGREDIENTS

PART		PRICE
CASE	FRACTAL DESIGN MESHIFY C	$189
PSU	650W CORSAIR CX650 **NEW**	$139
M/BOARD	ASUS ROG STRIX Z390-F GAMING **NEW**	$389
CPU	INTEL CORE I7-9700F	$549
COOLER	PHANTEKS PH-TC14PE **NEW**	$115
GPU	EVGA GEFORCE RTX 2060 KO ULTRA GAMING 6GB **NEW**	$619
RAM	16GB (2 X 8GB) GEIL EVO POTENZA @ 2,400MHZ	$110
SSD	500GB WESTERN DIGITAL WD BLACK SN750 M.2 PCIE SSD	$199
HDD	1TB SEAGATE BARRACUDA HDD	$70
OS	WINDOWS 10 HOME 64-BIT OEM	$140
PRICE:		$2,519

PC BUILDER

Turbo

Maximum power computing.

The reign of the Threadripper 2950X is over! The Threadripper series has long been toeing the line between powerful and overpriced, and with the 2950X stockpile running dry, limited second-hand units are rising in price. So rather than opting for the prohibitively expensive 3rd generation of Threadripper processors, we're losing a few cores and going for the top-tier AM4 chip instead, the 16-core Ryzen 9 3950X. It's impressively powerful, but not towards the point of redundancy. This means we've had to swap out the motherboard, so we've opted for Gigabyte's X570 Aorus Ultra. Our cooler remains compatible with the new motherboard socket, so we don't have to change that up.

One upgrade we do have to make, however, is the SSD. The move to 3rd-gen Ryzen means we now have PCIe 4.0 support, and we just have to take advantage. To that end, we've got a 1TB version of the Corsair Force MP600 SSD, which isn't too much more expensive than the Seagate BarraCuda drive we had been using but offers incredible 5GB/s read speeds.

We're also changing up the HDDs in both builds, swapping to a single 6TB BarraCuda hard drive in favor of the dual 3TB drives, which has saved us over $20 on both builds. Both systems are also receiving the EVGA SuperNOVA 850 GA, as we were stung once again by rising PSU prices. Overall we've saved a respectable $111 compared to last month's AMD Turbo build.

Over on our Blue Build (patent definitely not pending), the i9-9900K has dropped by a further $100. It's still one of the best gaming and multimedia-editing CPUs we've ever seen, so snap one up fast if you're looking to build a high-powered machine. We've also made a saving by swapping to the Asus ROG Strix Z390-H Gaming, since the previous mobo is out of stock at the time of writing. It's left our Intel turbo system over $610 cheaper than the AMD rig, which will perform on a similar level (better at rendering, somewhat worse for gaming). Hopefully next month we can shave a few bucks off the AMD machine too.

"One upgrade we do have to make, however, is the SSD. The move to 3rd-gen Ryzen means we now have PCIe 4.0 support"

AMD INGREDIENTS

PART		PRICE
CASE	NZXT H710I	$309
PSU	850W EVGA SUPERNOVA 850 GA **NEW**	$259
MOBO	GIGABYTE X570 AORUS ULTRA **NEW**	$529
CPU	AMD RYZEN 9 3950X **NEW**	$1,219
COOLER	CORSAIR ICUE H115I RGB PRO XT 280MM	$219
GPU	GIGABYTE GEFORCE RTX 2080 SUPER GAMING OC WHITE 8GB	$1,399
RAM	32GB (2 X 16GB) G.SKILL TRIDENTZ RGB @ 3600MHZ	$399
SSD	1TB CORSAIR FORCE MP600 M.2 PCIE **NEW**	$315
HDD	6TB SEAGATE BARRACUDA **NEW**	$269
OS	WINDOWS 10 HOMES 64-BIT OEM	$140
PRICE:		$5,057

INTEL INGREDIENTS

PART		PRICE
CASE	NZXT H710I	$309
PSU	850W EVGA SUPERNOVA 850 GA **NEW**	$259
MOBO	ASUS ROG STRIX Z390-H GAMING **NEW**	$439
CPU	INTEL CORE I9-9900K	$799
COOLER	GIGABYTE AORUS RGB LIQUID COOLER 280MM	$309
GPU	EVGA GEFORCE RTX 2080 SUPER BLACK GAMING 8GB	$1,349
RAM	32GB (2 X 16GB) CORSAIR VENGEANCE RGB PRO @ 2,666MHZ	$269
SSD	1TB SEAGATE BARRACUDA 510 M.2 PCIE SSD	$299
HDD	6TB SEAGATE BARRACUDA **NEW**	$269
OS	WINDOWS 10 HOMES 64-BIT OEM	$140
PRICE:		$4,441

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PC MASTERCLASS

A PC PROJECT BUILD WITH A PURPOSE

BUILD IT

A sound plan

This month, we're building an audio-recording PC to perfectly complement any home studio.

In theory, a good PC for music or audio FX editing in a studio environment needs to do two things well. The first, of course, is audio encoding and handling. With recent advancements in motherboards, it might be possible to cover this base with just a high-end board, since virtually all modern motherboards come equipped with on-board audio – the equivalent of a built-in sound card. Alternatively, you could go ahead and opt for a dedicated sound card, which is likely to provide you with better performance, or better yet an external DAC.

CHRISTIAN GUYTON

Christian likes taking things apart then putting them back together again.

"Background noise can spell doom for the sound quality in any live-recording studio, and the hum of fans inside a system can certainly be loud enough to disturb your sonic equilibrium."

The other thing you want is silence. Background noise can spell doom for the sound quality in any live-recording studio, and the hum of fans inside a system can certainly be loud enough to disturb your sonic equilibrium. Low-RPM fans, along with a quiet cooler and PSU, are therefore a necessity. Manual fan control via your case is also a good idea, making it a cinch to drop the system noise to a minimum when the mics go live.

So we have two core tenets to abide by for our build this issue. Of course, a sound-studio system should also be a competent workstation PC in general, so we need a decent processor along with a discrete GPU, since using integrated graphics would put more strain on the processor, and we want this system to run cool so our fans can stick to lower speeds. Lastly, we want plenty of storage for all those chunky audio files.

This is certainly an interesting machine to plan and build, as we're having to make use of what we can get hold of during the coronavirus lockdown, but we feel good about the choices we've made.

Audio ready

Some will argue that sound cards are obsolete in the present day, and they're right – mostly. If you're only using your PC for generic office work or entertainment, you can probably get away with just using your motherboard's on-board sound. If you work with audio professionally, though, it's a different story. A motherboard has limited space to dedicate solely to audio, while a discrete or external sound card has a lot more room to work with. To that end, we've chosen the Creative Sound BlasterX AE-5 Plus.

Sitting in the neighboring expansion slot is the GPU, a Gigabyte GeForce GTX 1650 4GB, which should be able to comfortably handle sound-editing software UIs running across dual monitors. The motherboard that hosts these two cards is also from Gigabyte: The affordable Z490 UD AC. Since we're using a separate sound card, we don't need a pricey motherboard with amazing on-board audio.

For the processor, we've got our hands on a shiny new Intel Core i5-10600K. Hyper-Threading gives it 12 threads from its six cores, and it has integrated graphics to fall back on if your GPU fails or you decide to upgrade. With a boost frequency of 4.8GHz, it's perfectly equipped for all but the most intensive professional audio work. 16GB of Corsair Vengeance LPX memory supports it, and we're keeping it cool with Noctua's NH-U12A air cooler.

For the drive, we've got a 250GB Crucial MX500 SSD to use as a boot drive and primary storage, backed up by 1TB of HDD storage in the form of Western Digital's 7200rpm WD Blue drive. Power is handled by a 550W be quiet! Straight Power 11. This doesn't leave much upgrade overhead when it comes to wattage, but the Straight Power 11 is rated at 80+ Platinum and runs quietly. We're also going with be quiet! for the case, with the Silent Base 801. We loved the 601, so hopefully this will be a pleasant experience too.

PART		PRICE
CASE	BE QUIET! SILENT BASE 801	$249
MOTHER-BOARD	GIGABYTE Z490 UD AC	$329
CPU	INTEL CORE I5-10600K	$499
CPU COOLER	NOCTUA NH-U12A BLACK	$209
MEMORY	16GB (2X8GB) CORSAIR VENGEANCE LPX DDR4-2666	$130
GPU	GIGABYTE GEFORCE GTX 1650 OC 4G WINDFORCE	$249
SOUND CARD	CREATIVE SOUND BLASTERX AE-5 PLUS	$249
PSU	550W BE QUIET! STRAIGHT POWER 11 80+ PLATINUM	$249
SSD	CRUCIAL MX500 250GB	$75
HDD	WD BLUE 1TB	$69
OS	WINDOWS 10 HOME 64-BIT	$140
TOTAL		$2,447

"A motherboard has limited space to dedicate solely to audio, while a discrete or external sound card has a lot more room to work with. To that end, we've chosen the Creative Sound BlasterX AE-5 Plus."

01 ALL YOUR BASE

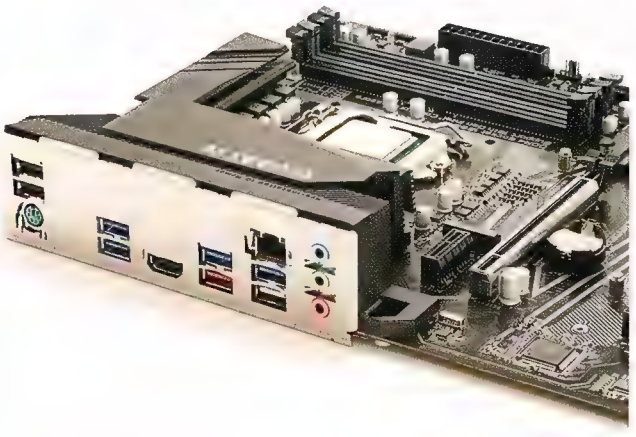
As tradition dictates, we begin with a case stripdown. Thankfully, the Silent Base 801 is very easy to work with; the sound-damping side panels lift off easily after being released with a simple button clasp. The front panel is also simple to remove, but since we'll be using the included case fans, there's no need to do so. For now, set both side panels aside, along with the accessories box. Even with the PSU shroud at the bottom, there's plenty of space to work with inside this case. It's possible to invert the layout, but we're not going to mess about with that. Before moving on, you may also want to remove the PSU bracket and some of the expansion card blanking plates at the rear of the case. Starting from the top, with the case upright, it's the second, third, and fifth plates that need removing. You can do this later, of course, but doing it now saves you from fiddling around with the case when you're trying to install your components.

02 SOFT AND SILENT

The Silent Base 801 comes with three case fans, and we'll be leaving all of them as they come. These are be quiet!'s 140mm Pure Wings 2 fans, which use textured fan blades to optimize airflow while minimising noise. Behind the motherboard mounting plate inside the case is a small fan controller, which enables you to hook up all three fans to the same manual switch on the front I/O. If your case doesn't come with these pre-connected, plug them in and route the cables neatly ahead of time, considering in advance where your power and I/O cables will go. There's plenty of room and cable-tying spots to neatly bundle excess cable lengths inside. If your build does end up looking a bit messy, the metal blackout panels will conceal your cables as well as your shame.

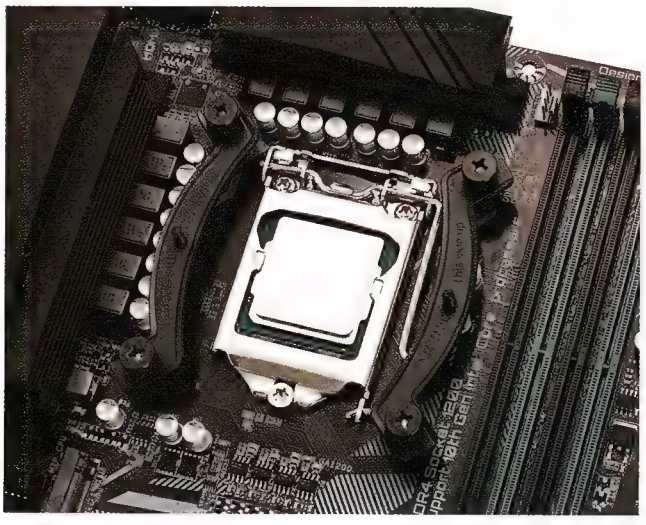
03 DUE PROCESS(OR)

The "UD" in this motherboard's name stands for "Ultra Durable," so we hope it'll last for a while. It's a sensibly priced Z490 board, not bringing any exciting USP to the table but pairing well with the 10th-gen Core i5 processor we're using. It also has two M.2 SSD slots for easy future storage expansion, and comes with QFlash Plus, which makes BIOS updates a breeze. Installing the processor is easy: Release and raise the metal retention arm on the CPU socket, open up the bracket and drop the chip into place once it is aligned correctly. The plastic cover should pop off once you lower the bracket back into place and secure the retention arm.



04 SHIELDS ENGAGED

Make sure the rear I/O shield is securely in place. It should come already attached to the motherboard, but this is a somewhat basic perforated metal plate, so be sure to double-check that none of the filaments are poking inside the ports if you bought your board pre-owned. Be careful when handling this, though: It's cheap steel, prone to grubby fingerprint marks that will be a pain to clean off. There's nothing much fancy going on back here, just plenty of standard USB ports for your connecting pleasure. We would've liked to splash out on USB-C or even Thunderbolt 3 connectivity, but ultimately it wasn't worth the associated price hike. There is, however, the two ports necessary for Intel dual-band Wi-Fi, should you need it.

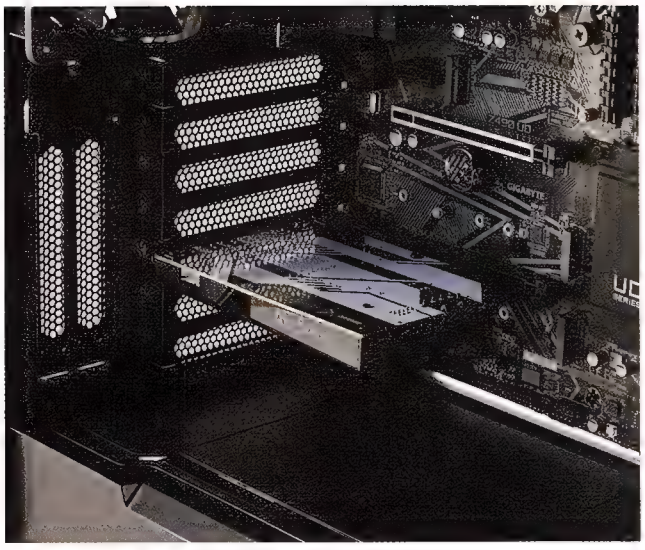


05 MAKING A BRACKET

Noctua's coolers are great for many reasons, not least because of their smart bracket design that makes them compatible with almost any contemporary CPU socket. The brackets can be fiddly, though, so unbox the cooler and work out which parts you need. It would be journalistic suicide to try and succinctly explain the process here, so you'd best stick to Noctua's instructions. The two upper bracket pieces that the heat sink will later be mounted on are helpfully labeled "this side up" for assembling convenience. These two pieces should curve outwards from the processor when correctly installed, as seen in the image below. Make sure all the screws are secure, but don't over-tighten them: We don't need to put this motherboard's "ultra durability" to the test.

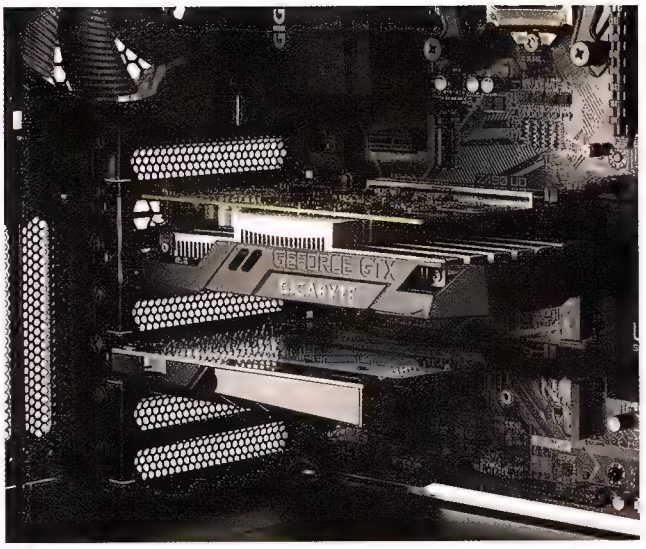
06 MOUNTING TENSION

Next onto the board is the RAM. This Vengeance LPX memory could probably be installed by a toddler; just release the clasps on the two grey DIMM slots and push each stick into place until you hear it click. With your bracket, memory, and processor installed, it's time to mount this motherboard. Lay the case on its side (you may want to replace the right-hand side panel for this) and lower the motherboard carefully into place, lining it up over the standoffs. Ensure that the rear I/O is correctly aligned, then screw the board down using the included Phillips screws. Once you're confident that the motherboard is secure, it's on to the next step.



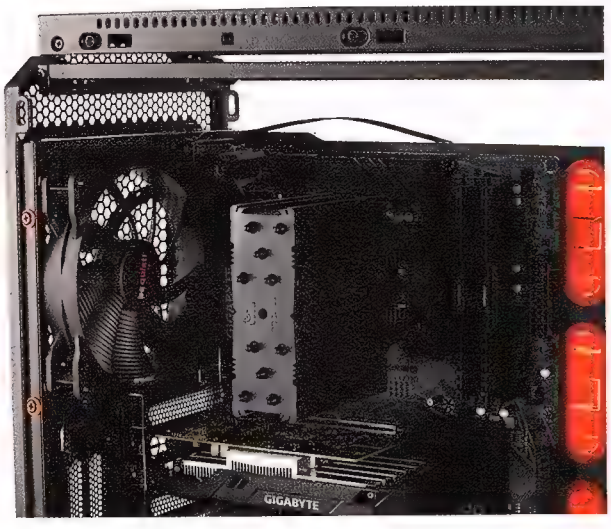
07 SOUNDING IT OUT

Setting up the Creative sound card is a relatively straightforward process – in this build, anyway. For no discernible reason, the AE-5 Plus has support for RGB lighting strips, but since the 801 case is windowless we're going to go without. Setting that up also requires use of a Molex cable, and we'd like to keep this build's interior as trim as possible. Simply plug the sound card into the lower PCIe expansion slot as shown in the image, and secure it to the backplate using the screw that previously held that blanking plate in position. If you're only accustomed to PCIe x16 graphics cards, don't worry: Even though the slot is much bigger than the card's connector, it'll still slot into place perfectly.



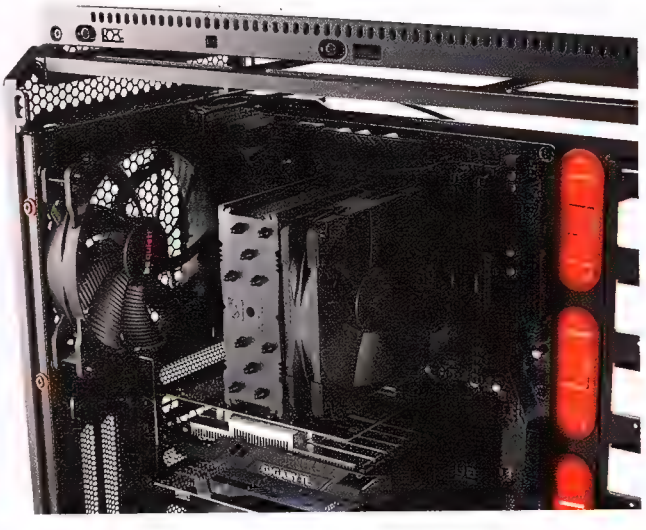
08 NO CABLES ALLOWED

Next up is graphics, the GTX 1650 slotting in neatly beside the sound card. Be careful: This 1650 is a bit flimsy, and you don't want to accidentally damage the plastic fans or casing during installation. Check that the clasp at the end of the PCIe slot has fastened correctly, then screw the GPU down at the two available points on the backplate. Since this is a smaller graphics card with a lower TDP, it draws all its power directly from the PCIe slot and doesn't require any additional cables, so there's no need for the usual 8-pin PCIe power cable here. Once the GPU is secured, you're all done: A nice, simple graphics card installation.



09 CHILLED OUT

Installing the Noctua NH-U12A cooler theoretically shouldn't give you too much trouble, especially given that you should have already fitted the more complicated mounting bracket. The heat sink should be positioned directly over the processor and screwed down to the bracket, but don't forget to place a small, pea-sized blob of thermal paste on that chip first. We recommend using something flat like a business card to evenly spread the paste across the top of the processor and remove any excess. Once this is done, lower the heat sink carefully onto the bracket, and affix both of the spring-loaded screws. Again, avoid over-tightening these, or you'll put too much pressure on the motherboard.



10 FAN THE HAMMER

Attaching the included all-black fan to the heat sink tower can be tricky. Attaching the fan first is not really an option as it would block access to one of the sprung screws we need to fit the heat sink in the first place. The NH-U12A comes with two delicate wire brackets, so be gentle. These brackets should hook through the holes in each corner of the fan casing, then enable you to clip the fan onto the ridged section on the side of the heat sink, with the wires slotting between the fins. Mount it on the front-facing side of the heat sink, positioned so it will direct air towards the fan at the rear of the case. If you're unsure, there should be tiny arrows on the fan casing that indicate which direction the air will be blown in. Setting it up wrong could be disastrous, as it would be working directly against the three case fans.

11 GOOD VIBES

To mount that Western Digital HDD, you'll need one of the individual drive cages that comes with the Silent Base 801. Secure the drive inside the cage with the provided screws, ensuring that the ports are accessible at the rear, then slot it through one of the modular gaps in the mounting plate from behind the motherboard. We're using the second slot from the bottom, as this allows for plenty of space, but feel free to experiment with different configurations (or simply mount it inside the fixed drive cage beneath the PSU shroud). The cage will affix to the case interior with three thumbscrews, which should leave the drive jutting out into the main cavity of the case. Using a 7200rpm HDD in a silent-running build might seem strange, but those drive cages have vibration-damping rubber grommets for minimal HDD hum.

12 CRUCIAL CONNECTION

Installing our SSD is even easier. The mounting bracket we want for 2.5-inch SATA drives is located directly next to the fan hub, so make sure you don't have any errant wires getting in the way. The bracket secures with a single thumbscrew after being slotted into place. Remove it and use four of the included screws to attach the Crucial MX500 drive. The drive's power and SATA ports should face downwards when installed, for easier cable routing later on. In fact, you can connect those SATA cables now; you'll want to deal with the smaller, more fiddly cables before the chunkier power cables.

13 ABSOLUTE UNIT

This PSU is a conventional ATX power brick, with a fully modular design. That's good, because we can eliminate virtually all excess cabling inside our case. Affix the mounting bracket to the power supply, then plug in the cables you'll need and feed them through the hole in the back of the case, before fitting and screwing in the PSU. Specifically, those cables are one 24-pin ATX power cable, one 8-pin CPU cable, and two multi-connector SATA accessory cables. One of those accessory cables can provide power both to the SSD and fan hub simultaneously. Before starting with power cables, get your front I/O cables plugged in. This shouldn't be too complicated given the lack of USB-C or lighting controls; plug the I/O cables into the appropriate headers on the motherboard, routing them in bundles where possible.

14 TIDYING UP

There's plenty of space for cable management here, so don't worry. Feed your two motherboard power cables through the nearest available slot and plug them into the board, then direct any excess towards the top of the case. As for the rest of the power cables, these can be connected to the drives and fan hub before being coiled beneath the PSU shroud, secured with cable ties if desired. You can (and should) also use cable ties to secure the larger cables to the rear of the motherboard plate, ensuring that they retain their position. When you're happy that this build is as tidy as it can be, simply replace the metal side panels so they click into place, and you're ready to power this system up and get installing!

01
The NH-U12A has support for a second fan to be mounted on the opposite side, should you decide you need some extra CPU cooling later on.

02
Decent GPUs that don't require additional PCIe power cabling are becoming something of a rarity these days.

03
Mounting drives in this case is wonderfully straightforward, and there's room for half a dozen more HDDs if that takes your fancy.

04
Hidden away beneath the be quiet!-branded PSU shroud, our power supply was impressively quiet throughout testing.

Sound, but not vision

Okay, we're going to need you to mostly ignore the benchmarking table this time around, as our standard selection of benchmarks doesn't do much to illustrate the intended performance of this machine. The low data-transfer speeds are a shame, but we knew we wouldn't be getting any higher than SATA III speeds. We will draw your attention to the CPU performance in Cinebench, however, which came out strong for a mid-range Intel chip. *Total War: Warhammer II* also saw a higher score than we had expected given this system's budget GPU, but since the game is CPU-bound it does make sense.

In order to properly test this system, we downloaded PassMark's SoundCheck program, which can be used for sound-card testing (among other things). The Sound BlasterX card had no difficulty reproducing sample rates up to 128,000Hz – the maximum offered by SoundCheck – and it was able to hit that target rate with impressive accuracy even when replicating white noise. Unfortunately we didn't have a set of high-end audiophile speakers during testing, but over headphones all the audio came through beautifully crisp and clear.

In hindsight, we might've put a slightly more powerful GPU in this system, if we were to build it again. A GTX 1660 Ti or 1660 Super would have been a significant step up in terms of gaming and rendering, or we could've leapt all the way up to an RTX card to turn this into a 4K audio and video-editing powerhouse of a workstation PC. It would mean including an extra power cable for the GPU, but the case has more than enough room for that. Of course, it would also lead to a hefty jump in price, and we're quite happy with how much the system we built cost us: A studio-quality sound-editing PC for under $3,000 is a fair deal indeed. While it's a massive, unwieldy case, the Silent Base 801 did make for an incredibly quiet machine. We may have achieved the same results with the smaller Silent Base 601 or 500, but we're very pleased with how softly this system runs. The fans are almost imperceptible even in a quiet room, and the HDD's whirr is completely muted. Having the manual fan control via the front I/O is nice, letting you pump the fans up to full speed when you start a lengthy encoding or rendering process, but even at maximum the fans aren't exactly noisy.

In terms of aesthetics, there really isn't much to see here. The windowless case is something of an oppressive, orange-accented monolith, but the clear absence of any RGB lighting or other decorative frivolities marks this system as a professional product, well-suited to a work environment. Keeping the interior tidy isn't hard, so air-dusting the guts of this case every few months should be easy.

APC LABS BENCHMARKS

Indicates best result

	Cinebench R15 Multi	CrystalDisk QD32 Sequential	CrystalDisk QD32 Sequential	Tom Clancy's Ghost Recon Wildlands	Total War: Warhammer II	Rise of the Tomb Raider	3DMark: Fire Strike
	Index	Read MB/s	Write MB/s	fps	fps	fps	Index
Purple Haze	1,470	561	517	34	30	60	8,003
Zero-point	1,152	3,400	1,720	39	46	60	11,101

Our zero-point consists of an AMD Ryzen 5 1600, 16GB Crucial Ballistix Sport LT @ 2666MHz, an EVGA GeForce GTX 1060 3GB and a 250GB Samsung 960 Evo M.2 PCIe SSD. All tests performed at 1080p at the highest graphical profile.

QUICK TIPS

APC experts solve computing problems

The *APC* team tackle problems across the spectrum of devices and software we use. Learn a new trick or fix you can use.

Random Freezes

I have a slim form factor build: AMD Ryzen 2700, 8GB Team T-Force Delta RGB 3,000MHz RAM, a single PNY factory overclocked XLR8 RTX 2060, 250GB Samsung 860 EVO SSD, and 2TB Hitachi hard drive. They're connected to an Asus ROG STRIX B450-F motherboard, which is stuffed in a Thermaltake Core G3 and connected to a Dell P1914S.

Recently my PC started acting up. Sometimes if I leave it on, the entire thing freezes – mouse, keyboard, and even the power switch become non-responsive. The only solution is to switch the power supply off and on, then reboot. It may be the drivers, but I have an issue installing them – what do I do with the compressed folder that was downloaded? How do I get my other drivers?

I also tried resetting my motherboard settings, but that brings the RAM speed down to 2,400MHz. I've not had any BSODs, nor has WebDiscover invaded my PC, although it got onto my family's devices (all fixed, however). Could it be the temps?
RECTOR-STINGRAY

APC responds: The random, unexplained computer freeze is our worst nightmare when it comes to troubleshooting. Where do we start with this? Let's open with a question about your PSU, which you didn't include in your spec. What wattage is it? Anything 500W or less isn't sufficient to power your PC's spec, so if you've tried to get by with a lower-wattage PSU you should upgrade to 600W as a comfortable minimum, or 750W+ if you can afford the premium that goes with the small form factor PSU your case demands.

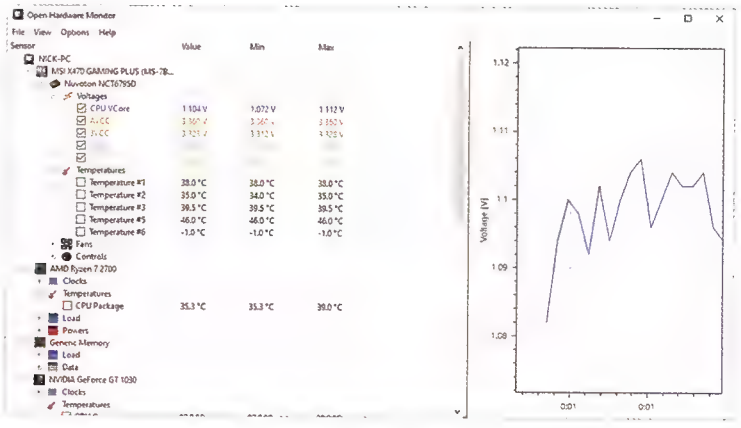
Second, could the small size of your case be a factor in random freezes if it's caused by temperature spikes? Use a tool like Open Hardware Monitor (**https://openhardwaremonitor.org**) to monitor your voltage and temperature over an extended period. Select "Options > Logging" to start recording the figures every second, then after your next freeze, reboot and open the "OpenHardwareMonitor" folder. You'll find a CSV file that you can open in Excel or LibreOffice Calc.

Sudden freezes linked to temperature spikes should be addressed by investigating the interior of your case – check there's adequate ventilation into and out of the case, and around its components by tidying your cables, and ensure that all the fans are spinning when you power up. Check that your CPU heatsink is securely attached and has adequate thermal paste.

If you notice voltage changes – typically in the CPU VCore setting – enable the "High performance" power plan in Windows and it should smooth out. If, however, the voltage continues to fluctuate wildly – particularly just before a freeze – turn your attention back to the PSU and the possibility it may need replacing, even if it offers sufficient power.

Corrupt RAM may also be the cause. Search for "memory" and open Windows Memory Diagnostic. Choose to run the test now or when you next restart your PC, and press F1 when it starts to select the "Extended" test, before pressing F10 and waiting for the tests to complete (this may take several hours). Windows will display the results after rebooting – if there are errors, your RAM will need replacing.

Finally, check that you're running the latest BIOS version for your board (version 3003 as of May 2020) and that your drivers are up to date – use the Asus Armoury Crate tool (after installation, go to "Settings > Update Center" to see what's available) if you're struggling to update your key drivers.



Open Hardware Monitor tracks all your PC's sensors.

Compatible batteries

I'm in a pickle. Two years ago, I bought a Realtree Xtra camo-style HP laptop with an Intel Pentium chip. The problem is that my battery is basically dead, and the laptop now only works if I keep it plugged in. I've had major problems tracking down the right battery and bought and returned at least three different ones. What's particularly frustrating is that sourcing batteries for my old HP Pavilion dv7 laptop is much easier – needless to say I'm quite grumpy!

Do you know what battery I need? If so, I would really be grateful.
JON SHIMAMOTO

APC responds: An exact laptop model number stamped on the underside of the laptop would have gone some way to helping us target a specific battery (as would telling us the batteries you'd already tried). That said, there appears to be only one HP model matching your description, the HP 15-ay070wm. Searching for that plus the word "battery" gives several matches, including this from Reliable Laptop Parts

(**https://bit.ly/MPCaugbattery**) for $39.99.

You don't mention if you've followed HP's own support services, so we recommends you go down that path. Start by visiting **https://support.hp.com/us-en/document/c04700771** for some guides and tools to test the health of your current battery. If the tools suggest that the problem isn't with your battery, you might get lucky opening Device Manager, expanding "Batteries" and then uninstalling any ACPI options, before rebooting to allow it to start recharging properly again. If your battery has definitely reached the end of its life, then the support pages also help you determine what info you need to source a replacement, and provide you with a link to the HP Parts Store – see **https://support.hp.com/us-en/document/c00821572** for the info you need if you want to stay on the official path.

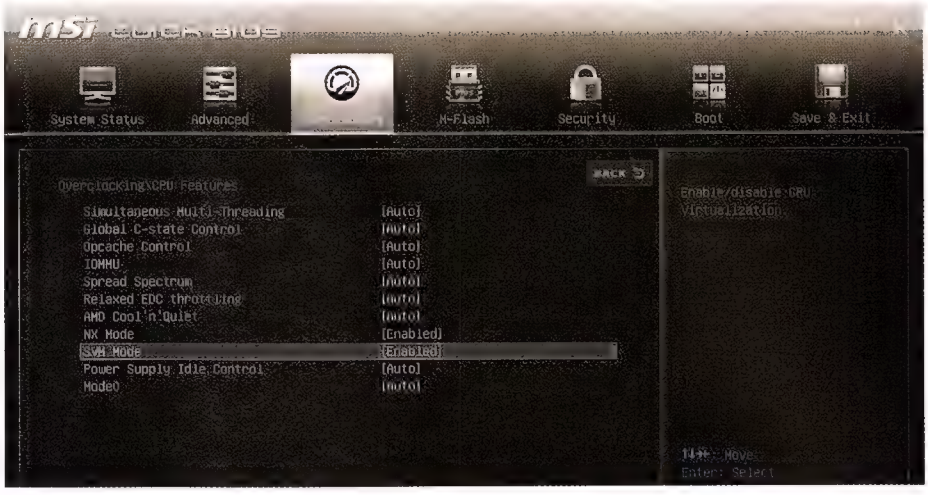
Two sticks or four?

Two questions if I may. First, I built a new system mainly for gaming. I chose to populate the board with four 8GB G.SKILL F4-2800C15-8GVR RAM sticks, but after going through the manual discovered the board (Asus Maximus Hero XI) uses a dual-channel memory architecture. Performance-wise, did I make a mistake filling the four slots – would I have been better off using just two 16GBssticks? Also, would higher spec'd memory provide any performance benefit?

Second, I reused my Corsair H100i AIO from my old system. In this system, either the fans or the pump – can't be sure – pulsates, particularly in performance mode. I've checked the Corsair Link utility while it's pulsating but don't see anything unusual: CPUs are a steady 32 C. Would this indicate something is failing – I bought this cooler in July 2014?
STEVE VANETTI

APC responds: There's virtually no difference in performance between four sticks of 8GB or two sticks of 16GB, just as there's little difference between running 2666, 3000, or 3200 RAM (outside of Ryzen). The main advantage of choosing two sticks of 16GB is that you'd leave two slots spare for future upgrades, but given you've got 32GB that's not going to be an issue for some time.

As for your second question: Despite its age, we suspect the pulsating is caused by the placement of the cooling pump in your new system and the flow of air around it. Google "Corsair H100i AIO pulsating" and you'll see some videos and forum posts that will provide plenty of potential help and advice to steer you towards isolating the likely cause, and the best way to reconfigure the pump to minimise the problem.



Hardware virtualisation needs to be enabled in the UEFI/BIOS.

COD: Warzone crash

I have a problem. Call of Duty: Warzone crashes without any error info. Basically, it closes like I hit exit after 5-10 minutes of play – on any battle or practice mode. I've tried updating everything, even switched back to Windows 10 1903 and went online trying every fix through settings I could find – such as making sure all the shaders are fully downloaded in the game before starting. No dice.

Yet one piece of advice I've found that does work is to sit on the menu screen for 10 minutes before running. Why would that fix things? Seems like the old Nintendo "blow in the cartridge" fix.
JOSHUA GIACCHINO

APC responds: It looks like a common problem, judging by the comments on one Reddit post (**https://bit.ly/MPCaugreddit**). Scroll through this to reveal several different workarounds to try. The first one covers some of the steps you've mentioned following, but others involve creating a special BAT file to launch the game with, renaming "ModernWarfare.exe" as "ModernWarefare.exe1" each time, and removing the player folder in your documents, running a series of commands (make this a BAT script to save time), restarting your PC, and then renaming the program executables.

Long story short? The game is bugged to hell, and until the devs get a fix on the problem you've two choices: Accept the 10-minute wait before playing each time, or find a more stable alternative.

Can't enable sandbox

I would like to use a sandbox, but cannot access it from Windows Features, as the option is greyed out. When I put the cursor over it, it read "Sandbox cannot be installed: virtualization support is disabled in the Firmware." When I went into my Asus Prime A270-A motherboard's BIOS, I found nothing there that would apply to Sandbox. What am I missing? My processor is an Intel i7-7700K, so it should be compatible.
KEN PAYNE

APC responds: You're looking for the hardware virtualisation feature, which is usually buried deep inside the BIOS/UEFI settings. In your specific case, you need to navigate to "Advanced > CPU Configuration," where you'll find the "Intel Virtualization Technology" setting – switch this to "Enabled," save your changes, and you should be able to make use of Sandbox.

Other BIOSes may bury the settings deeper still using even more obscure terminology; taking APC's X470 Gaming Plus motherboard as an example, you need to navigate to "Overclocking > CPU Features" and enable the "SVM Mode" setting. If all else fails, your mobo manual should provide a route to the setting, or keep an eye out for terms like "VT-x (Intel)," "AMD-V," or even "Vanderpool."

A quick note: It also requires Windows 10 Pro.

Customise the desktop with Rainmeter

Make Windows truly your own, with Alex Blake.

The default Windows desktop customisation experience is fine, but not much more. You can change your wallpaper, adjust window accent colours, and switch up your lock screen – and that's about it. If you want more power to change up your computer's style, you will likely be disappointed with the results.

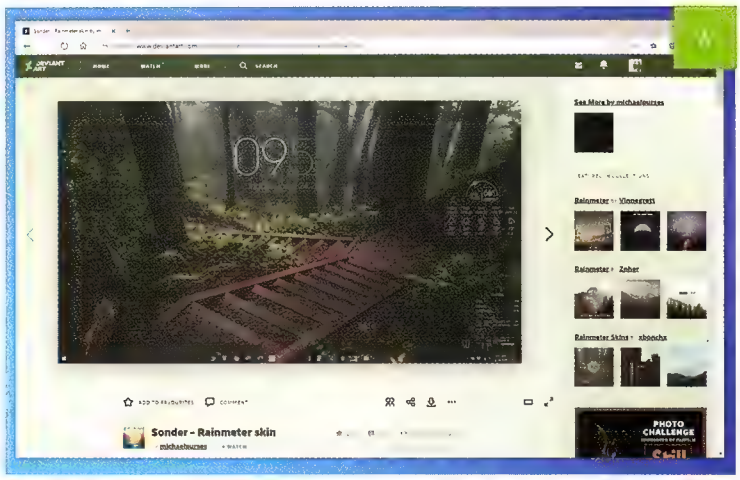
That all changes with Rainmeter. This lets you install various "skins" on Windows, all of which can add new flavours of visual flair to your desktop. These range from small widgets showing the time and weather to full-blown overhaul suites with moveable items, redesigned taskbars, and custom shortcut icons.

You can even build your own skins if you have a bit of coding knowledge. We will not cover that in detail today, but it is an area to explore further if it feels like your sort of thing. The good news for everyone else, though, is that Rainmeter requires no coding knowledge whatsoever, and you can easily customise most skins to your heart's content with a few simple clicks.

YOU'LL NEED THIS

RAINMETER
www.rainmeter.net

WINDOWS 7 OR LATER
Preferably use Windows 10 as it's still supported by Microsoft.



Getting started

Head to **www.rainmeter.net** and download the program's installer, then follow the on-screen instructions to set it up on your computer. You can either choose the final release or the latest beta – betas are stable and have the latest bug fixes, but they may occasionally have features removed before they become finalized.

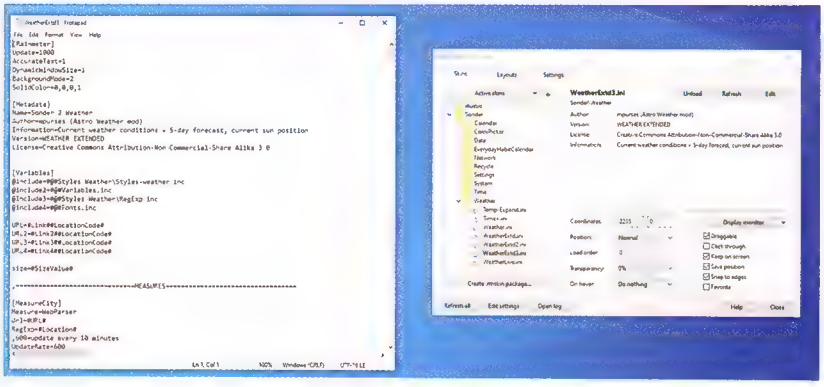
Once it's installed, Rainmeter will show a few basic widgets (known as "skins") on your desktop – the time and date, your PC's component statuses, and more. It will also present you with a welcome splash screen. These are all part of a pre-installed suite called Illustro. In the Windows Notification Area, right-click the Rainmeter icon, then click "Skins > illustro > Google > Google.ini." This will place a Google search box on your desktop, which you can move around wherever you like. To remove it, right-click the widget, then click "Unload skin." This principle applies to all skins.

You can move each skin to wherever you want, and it will remain there when you next restart your computer. To move more than one skin at once, hold Ctrl and Alt, then click on the elements you want to move; they will turn a different

Making a skin

If you want to create your own skin – or make some more extensive edits to someone else's – you will want to get to grips with the Lua coding language and the elements that are used to create Rainmeter skins.

Each skin is comprised of various parts. "Measures" read information from your computer (such as its GPU temperature), a website, text file, or other external source. "Meters," on the other hand, are used to create visuals, including charts, images, buttons, and more. To make your skin work with other skins or apps, you will need to use commands called "bangs," while you can customise things like a skin's colours or position using text strings that are called "variables."



These are the basic building blocks of Rainmeter skins. The Rainmeter website has an excellent, extensive manual that will walk you through every step of creating your own skin. It also has a wealth of handy tips and tricks, as well as a forum that's full of helpful topics and discussions.

The Sonder Rainmeter suite

01 SKIN SETTINGS
The Sonder skin has its own settings panel, from which you can customise the skin appearance. Not all skins that are available come with a settings panel like this one, though.

02 TIME AND DATE
Sonder adds a large time and date display, which is much more convenient than the tiny clock in the corner of the Windows 10 taskbar.

03 COLOUR PICKER
Adjust the colors of various elements using a colour picker. Easy customisation is something to look for in a skin suite.

04 VARIANTS
Check to see if your chosen suite offers variants for each skin element. If you do not like the default option, you will be able to select something else from the choice that's offered.

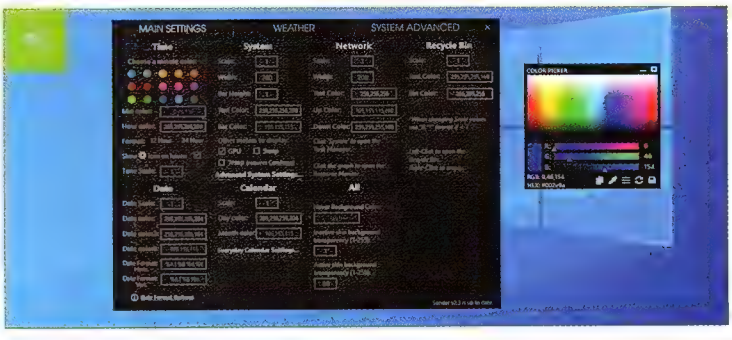
05 EXTRA SKIN WIDGETS
Sonder also provides plenty of extra skins to add to your desktop. Check what your chosen suite offers, as each one will vary.

color to show they are selected. Now just drag one, and the others will move with it. Click anywhere on the screen to deselect them.

Finding more advanced skins

The Illustro skin does a decent job as a basic skin explainer, but it would be a shame to stop there. Rainmeter also has an enormous range of user-created skins available, many of which are truly breath-taking. In this example, we will make use of the Sonder skin.

Head to the official Rainmeter DeviantArt page at **www.deviantart.com/rainmeter/gallery**. DeviantArt is one of the largest artistic communities on the internet and houses a curated selection of excellent Rainmeter skins. At the link above, click "Skins," then navigate to the entry titled "Sonder – Rainmeter skin" **[Image A]**. Under the main image, click the download button (you'll need a free DeviantArt account), and save the skin.



Double-click on the RMSKIN file to launch the installer, then follow the on-screen instructions. When it finishes, you will see a settings box, as well as elements such as a large time display, your system details (such as CPU usage), a Performance Monitor icon, and more.

Make it yours

Let's start customising our widgets. Move each element to where you want it on the screen. Rainmeter remembers their positions so you will not have to keep moving them. Next, right-click the weather forecast and click "Variants." Here you will see several different options; click "WeatherExtd2.ini" and the weather widget changes to a more horizontal layout. Try this with

each of the other widgets.

Next, go to the settings box (if you have closed it, hover over the time and date skin, then click the cog icon). On the "Main Settings" tab under the "Time" heading, choose a new color for the clock's minute display. By default it is dark green, but this might not match your wallpaper.

We have chosen a dark blue to go with our Windows background picture **[Image B]**. You can change everything, from the size of each widget to the colours it uses and the date formats displayed.

Now click the "Weather" tab. It is no use getting weather for Houston when you are in New York City, for instance, so you will want to make sure your weather is relevant to your location. Rainmeter uses **https://weather.com** to get its forecasts; head there and search for your city, copy the long code at the end of its web address, then paste it into the box on the "Weather Settings" tab and press Return **[Image C]**.

The "System Advanced" tab lets you customise the info you see on your hardware components. You will get the most benefit from this if you use the "System-Advanced.ini" variant, which displays more detailed information. Part of its functionality relies on the HWInfo app, although Sonder still works without it – you will just get more specific data with this installed.

Managing a Rainmeter skin

An important aspect of Rainmeter is its "Manage" screen. This enables you to control each skin and widget in depth. To access it, right-click the Rainmeter icon in the Windows 10 Notification Area and click "Manage," or left-click the icon once.

Click the "Active skins" drop-down box, then click "Sonder\SonderWeather\WeatherExtd2.ini."

This will load the settings for the weather widget **[Image D]**.

If you want to prevent the skin from being accidentally moved, untick the "Draggable" checkbox. "Click through" enables you to click any element sitting underneath the widget, such as a file on your desktop. To aid with positioning, make sure "Keep on screen," "Snap to edges," and "Save position" are all checked. Alternatively, deselect the first two to move your skins exactly where you want them, without having them snap to the edges of your screen or each other.

To the left of these options are a few more visual and positioning options. You can use the "Coordinates" boxes to get some fine-grained control over where your widgets sit on your screen. The "Position" drop-down box determines whether the skin sits on top of other windows at all times, while you can also decide how transparent it is and whether it fades in or out when you hover your mouse over it.

Once you have finished with these controls and options, you should have a perfectly customised Windows 10 desktop that is tailored to your needs. The Rainmeter developers encourage users to experiment with skins and adjust them as needed, so you could always tinker with them even more if you so desire (see the boxout "Making a Skin" for more information).

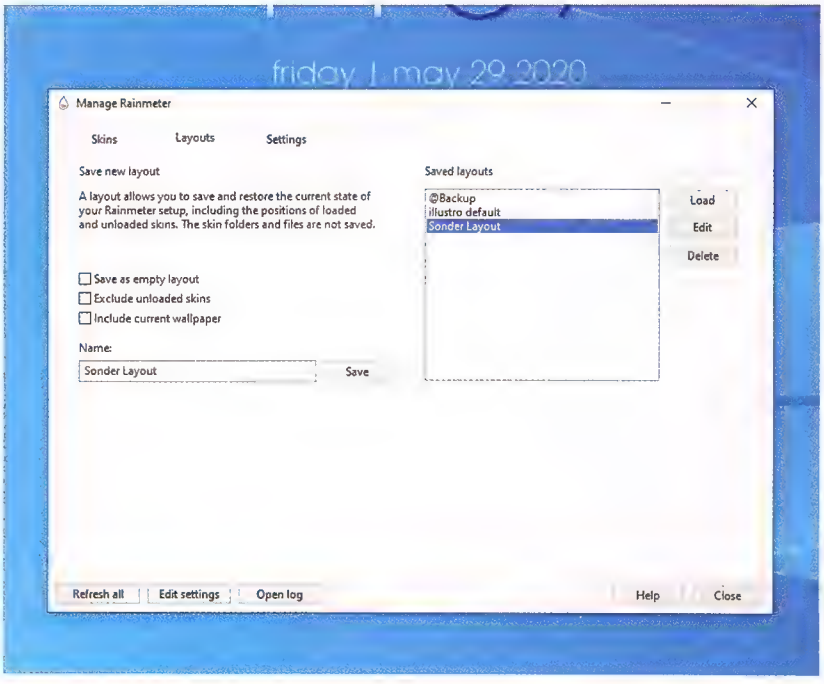
Saving your skin

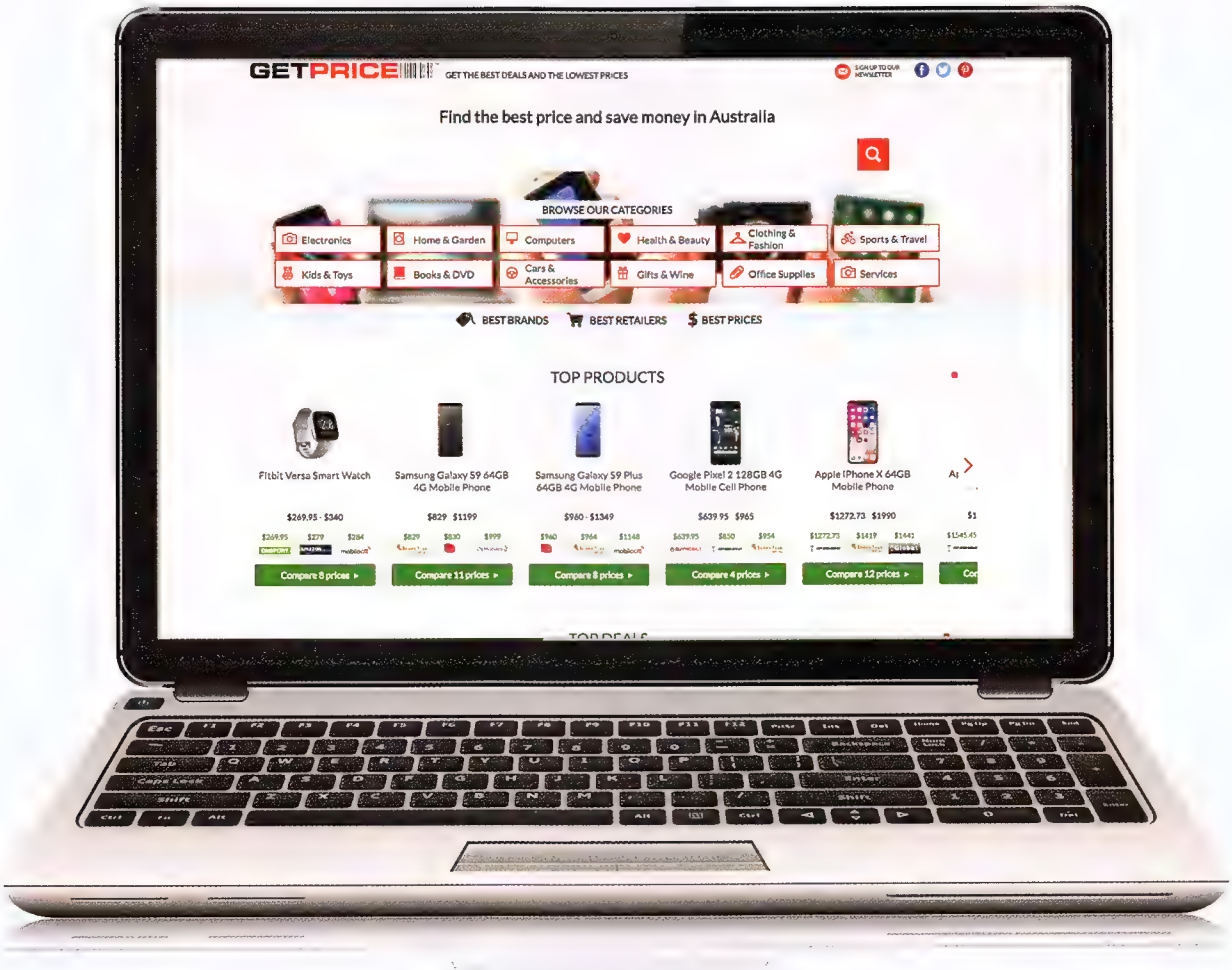
Rainmeter has a couple of different ways to save and export your skins, but you will need to know the differences to ensure your files are safely backed up.

The first is your skin layout, which saves the current positions and settings of your skins. Open the program's "Manage" panel, then click the "Layouts" tab. Click the name of the skin you want to save on the right, then click "Save."

Note that layouts do not save any of the files you use in your skin (such as images), nor any of the skin's folders. To back these up, you can copy the skin's folder from "Documents > Rainmeter > Skins" to a safe location.

Alternatively, you can export the skin as a RMSKIN file. This will include everything needed for the skin to run, including its files. Open the "Manage" window, click your skin's name, then click "Create .rmskin package" and follow the on-screen instructions. When you are finished, safe the RMSKIN file to a backup location.





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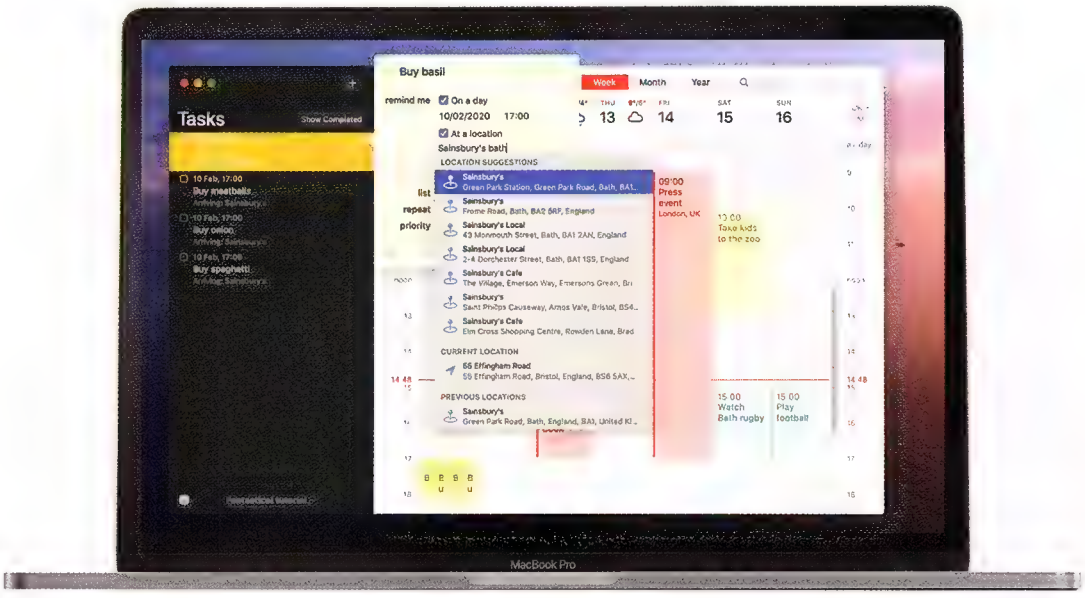


MAC

Set up tasks in Fantastical

Combine all your reminders and calendars in one handy app. Alex Blake shows the way.

Fantastical may look like a calendar app, but it's also an excellent reminders tool as well. In fact, integrating your reminders directly into your calendar within one app makes life a lot easier.

Instead of relying on multiple different apps to get yourself organised and hoping they all sync up properly, you can simply open Fantastical and start creating reminders (known as tasks in the app) straight away. Doing it this way means you get to make use of Fantastical's excellent natural language support, which makes entering your tasks a cinch. The app also syncs everything to all your Apple devices, so there's no need to worry if you'll get a reminder created on your Mac when you're away from your desk.

This tutorial will take you through everything you need to know to master setting up tasks in Fantastical, from the basics of creating new reminders to a few lesser-known tips that'll take your experience up a notch. So let's get started.

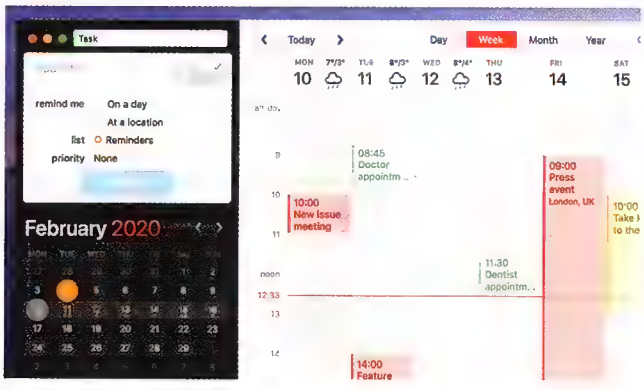
"Instead of relying on multiple different apps to get yourself organised and hoping they all sync up properly, you can simply open Fantastical and start creating reminders (known as tasks in the app) straight away."

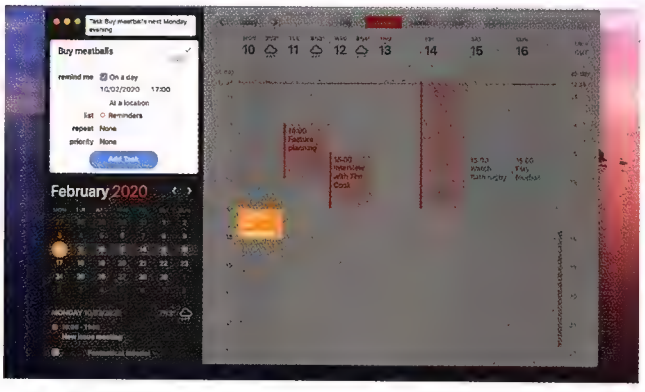
IT WILL TAKE
15 minutes

YOU WILL LEARN
How to merge reminders and calendar events in Fantastical

YOU'LL NEED
A Fantastical subscription, macOS 10.13 or later, iOS 13 or later, watchOS 6 or later

HOW TO: Create and organise tasks



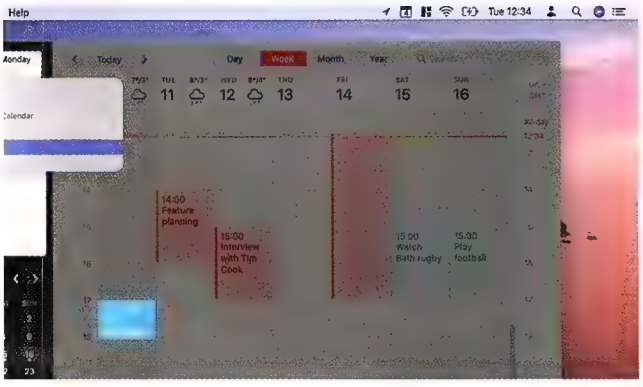


01 ADD A NEW TASK

Creating a task is simple. Click the '+' icon, then start by typing 'Task', 'Todo', 'Reminder' or even option-command. This switches from an event to a task. Alternatively, click the slider on the right of the new event window.

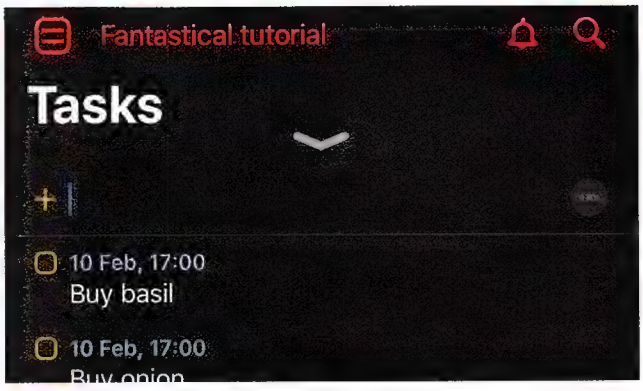
02 SET A DATE

Fortunately, Fantastical accepts natural language input. To add a date and time to your reminder, just type 'Sat 3pm' or 'Next Monday evening' and the app will understand what you want and schedule it accordingly.



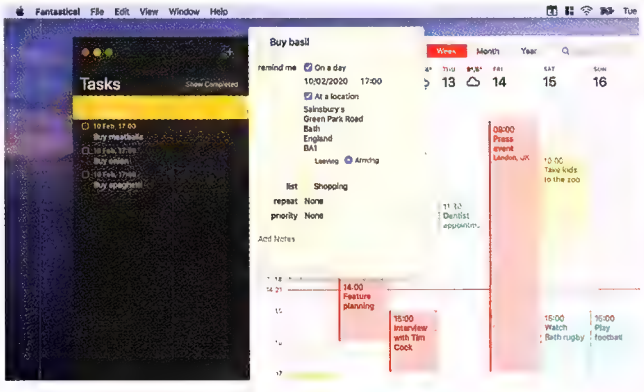
03 PICK A TASK LIST

Your default task list is set in Fantastical's settings. To change the list the task appears on, type a forward slash ('/') when adding it, then pick an option from the resulting list. You can start typing to narrow down the results.



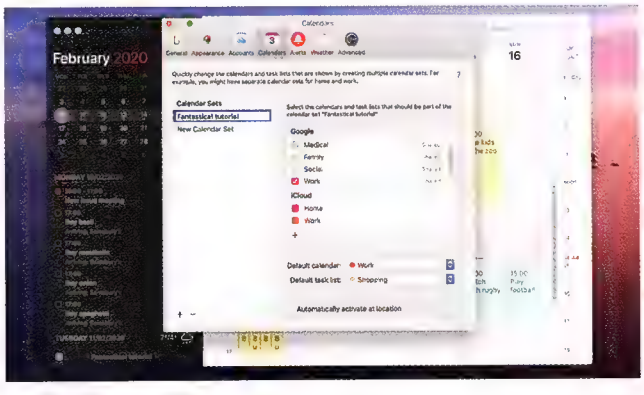
04 ADD A TASK ON IOS

On iOS, tap the calendar icon (top left corner), then tap Tasks. Tap New Task, then start typing. The same shortcuts work on iOS as on Mac, so you can use natural language, type a '/' to select a task list, and more.



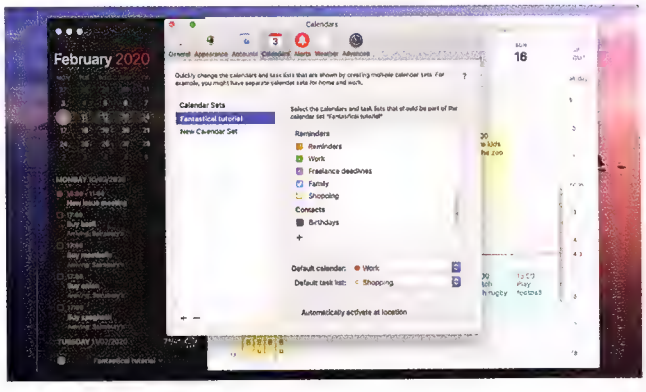
05 DESTINATION REMINDERS

Back on Mac, click a task, then tick the 'At a location' checkbox. Click Add Location and start typing a destination; the app will suggest locations. Select one then click Arriving to be alerted of your reminder when you arrive.



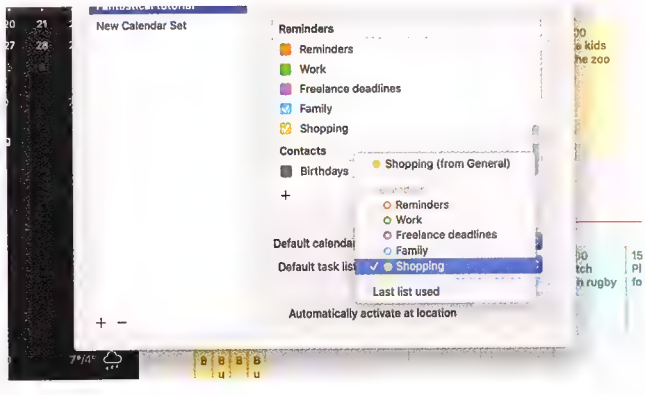
06 NEW CALENDAR SET

Fantastical uses Calendar Sets to organise tasks and calendars. Click Fantastical > Preferences, then click the Calendars tab. Create a new Calendar Set in the left-hand column and give it a name.



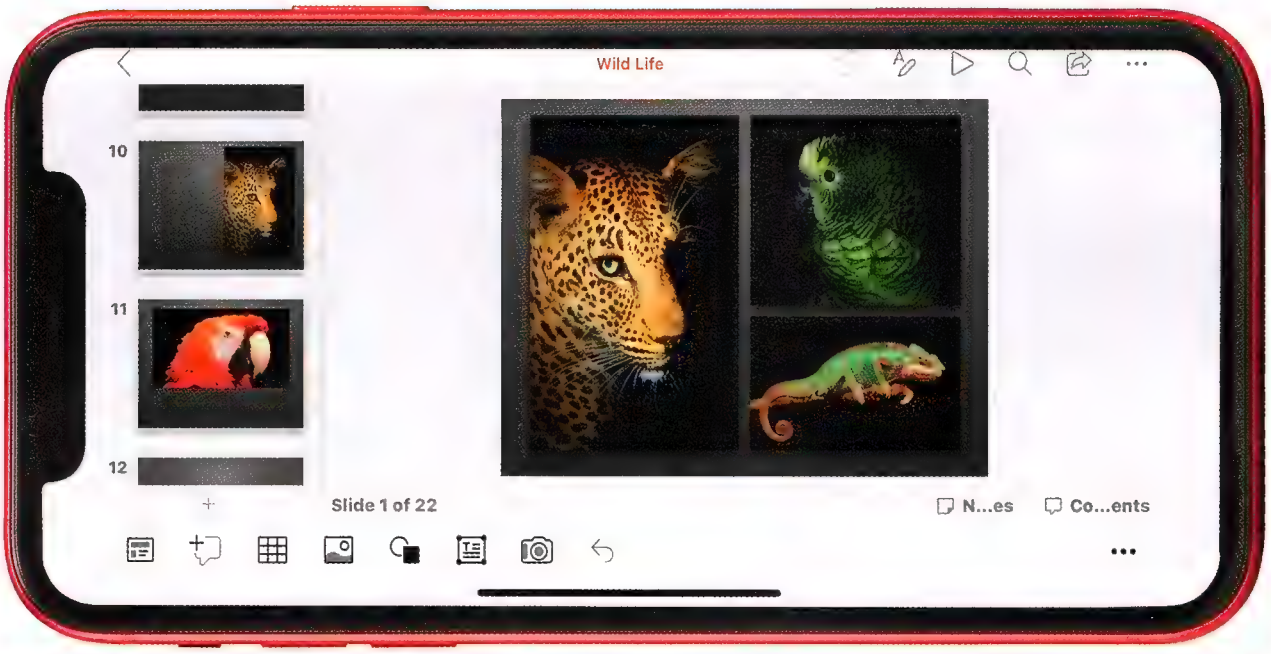
07 FILL WITH LISTS

In the main window of the app's Preferences pane, you'll see all the calendars and reminders lists you've loaded into Fantastical. Tick as many as you want to see in the app when this Calendar Set is active.



08 CHANGE THE DEFAULT LIST

If you find yourself using one task list more than others, you can make it the default list. Go to Fantastical > Preferences and click the Calendars tab. Under 'Default task list', choose a new option.



iOS

MS Office on the move

Access all the Office apps from one handy app when you're out and about.

Microsoft has made some big changes to Office on iOS, at least on iPhone: instead of having separate apps for Word, Excel, Powerpoint, Notes and Office Lens, it's combined them into a single app. That doesn't just make it easier and faster to access your various Office documents and tools. It also reduces the amount of space needed for Office on your device.

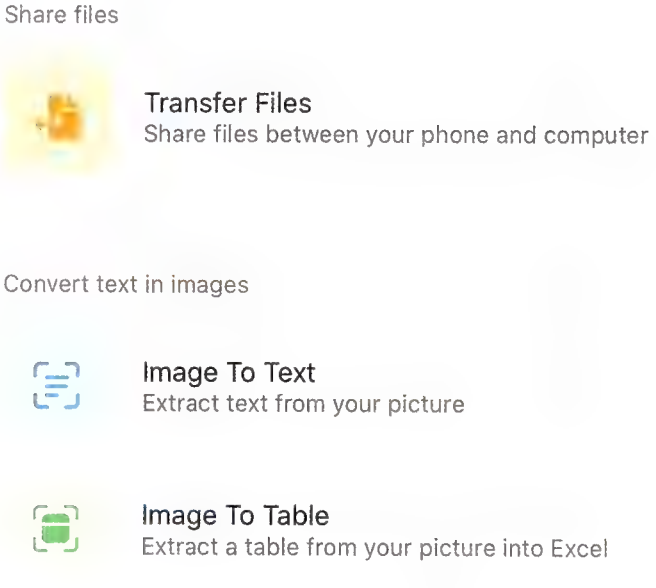
Microsoft has done a superb job here. It still feels like Office, but this isn't a desktop app that's been squashed into a smaller screen. It prioritises speed, simplicity and the kind of tasks you'll do when you're away from your Mac. Whether you're updating a spreadsheet, signing a contract or scanning somebody's business card, everything you need is available within a couple of clicks.

Of course, the app syncs with Microsoft's own excellent OneDrive app, but you can also get files from and save files to Dropbox, Box, various corporate cloud services and Apple's own Files app.

IT WILL TAKE
10 minutes

YOU WILL LEARN
How to use Microsoft Office on iOS

YOU'LL NEED
Phone running iOS 12 or later


Share files
Transfer Files
Share files between your phone and computer
Convert text in images
Image To Text
Extract text from your picture
Image To Table
Extract a table from your picture into Excel

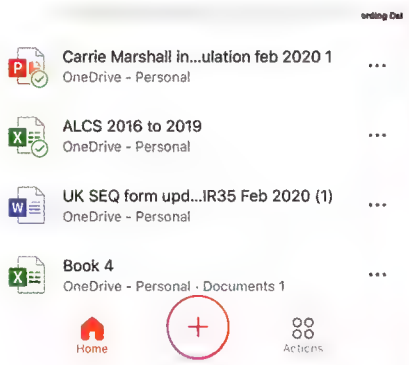
The Actions button provides fast access to common tasks such as scanning text, creating PDFs and sharing files.

iPad issue

It's perfectly possible to create documents in the iOS app, but we'd much rather do that on the big screen of an iPad – ideally one with a separate keyboard.

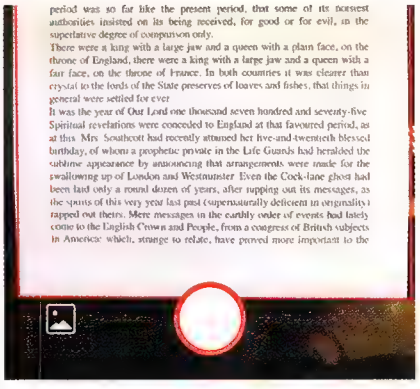
Unfortunately, while this app does run on iPad, it does so as a phone app; you don't get the benefit of the iPad's much bigger screen, which is a shame. For the time being, you'll get a better Office experience on iPad if you use the stand-alone apps.

CARRIE MARSHALL



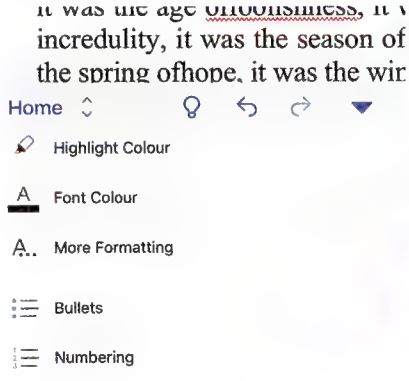
01 OPEN IT UP

The new Office app for iPhone puts everything in one place – documents, spreadsheets, presentations and notes. You access everything through the home screen, which shows your most recently used documents in date order.



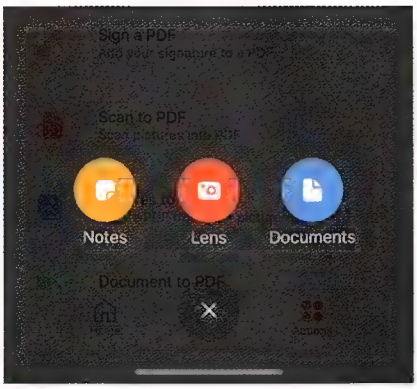
04 SCAN SOME WORDS

Word's document scanner either works brilliantly or terribly. If you want the former, you'll get best results with good contrast large print or by getting close with the camera. A red box appears when Word is happy to scan.



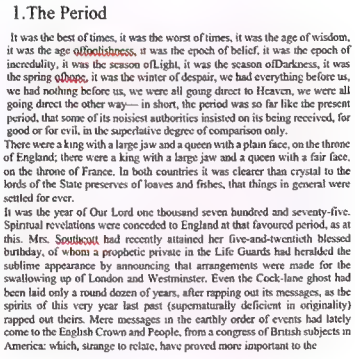
07 GET MORE TOOLS

The toolbar above the keyboard provides quick access to key tasks such as formatting. If you tap on the three horizontal dots at its right-hand side, a bigger menu pops up with more detailed options. Tap the arrow to minimise it.



02 START IT UP

To create a new Office document of any kind, tap the big '+' button at the foot of the home screen. This gives you three options: Notes, for jotting stuff down; Lens, which you can use to photograph whiteboards; and Documents.



1.The Period

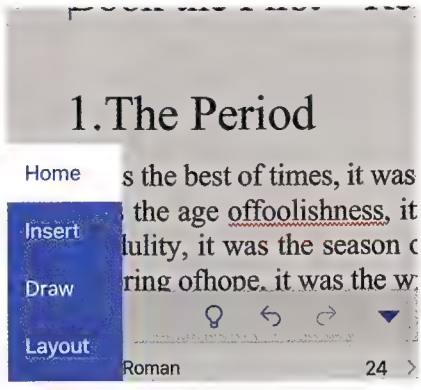
It was the best of times, it was the worst of times, it was the age of wisdom, it was the age offoolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season ofLight, it was the season ofDarkness, it was the spring ofhope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way— in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.

There were a king with a large jaw and a queen with a plain face, on the throne of England; there were a king with a large jaw and a queen with a fair face, on the throne of France. In both countries it was clearer than crystal to the lords of the State preserves of loaves and fishes, that things in general were settled for ever.

It was the year of Our Lord one thousand seven hundred and seventy-five. Spiritual revelations were conceded to England at that favoured period, as at this. Mrs. Southcott had recently attained her five-and-twentieth blessed birthday, of whom a prophetic private in the Life Guards had heralded the sublime appearance by announcing that arrangements were made for the swallowing up of London and Westminster. Even the Cock-lane ghost had been laid only a round dozen of years, after rapping out its messages, as the spirits of this very year last past (supernaturally deficient in originality) rapped out theirs. Mere messages in the earthly order of events had lately come to the English Crown and People, from a congress of British subjects in America: which, strange to relate, have proved more important to the

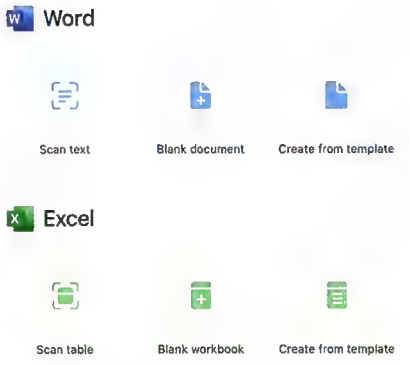
05 WORK WITH YOUR TEXT

After a short processing delay, Word will show you the photo and give you the opportunity to crop it, share it or redo it. It'll then create a new document and show the scan underneath it so you can look for any mistakes.



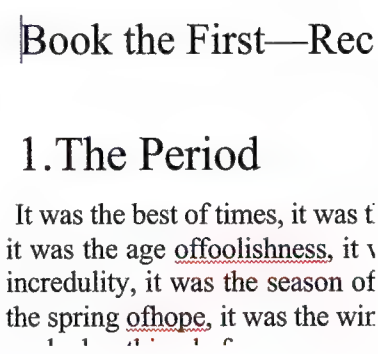
08 CHANGE THE TOOLBAR

If you tap on the bit that says Home, you can change the toolbar to bring up different tools: layout tools, reviewing tools, drawing tools and so on. The name of the toolbar sits at its very left-hand side, just tap it to bring the menu back.



03 CHOOSE YOUR TOOL

If you click on Documents, you'll see this screen, which gives you three options for each of the key Office tools: Word, Excel and PowerPoint. We're going to use one of the cleverest Office features here by choosing Word > Scan Text.



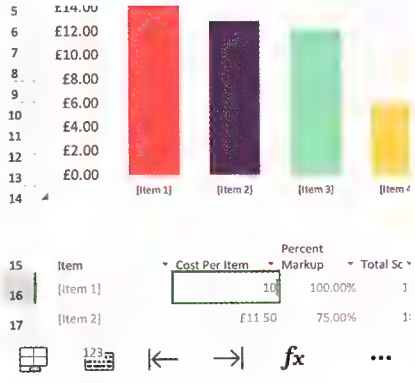
Book the First—Rec

1.The Period

It was the best of times, it was t
it was the age offoolishness, it
incredulity, it was the season of
the spring ofhope, it was the wir

06 EXPLORE THE INTERFACE

Word on the desktop is quite a busy thing, but it's much simpler on iPhone. Tools stay out of the way until you need them. Here we're at the top of our document so we get top-level options such as view, search and share.



09 EXPLORE EXCEL

Excel's interface works in the same way as Word: most of what it can do is kept off-screen until you actually need it. Here we've selected a cell, and as you can see the context-sensitive toolbar pops up with relevant options.

Manage your files

Shed your clunky graphical file management habits and let Jonni Bidwell show you the grown-up way to wrangle files.

We're hell bent on having you organise your files this month. So listen up. Nnn, or n cubed, bills itself as the fastest file manager ever written. It's based on Noice, so the name is a recursive acronym for Nnn's Not Noice.

Nnn takes things to the next level. It's written in C, and aims to have as small a memory footprint as possible. As a result, it's pretty minimal and won't be to everyone's tastes. Heck, it doesn't even have a configuration file, so if you want to change things you can do so through environment variables, plugins and command line switches.

But let's not get ahead of ourselves. You can install nnn in Ubuntu with:

```
$ sudo apt install nnn
```

but you'll get a slightly older version (3.0 if you're using 20.04, as opposed to the current 3.2). If you want the latest and greatest you'll find RPMs and DEBs in the releases section of the project's GitHub at **https://github.com/jarun/nnn** and you may as well just install that over the top of the one in the Ubuntu repos. The dependencies won't change – all it needs is the C library and Ncurses. Check the wiki to see some of the other tools it can integrate with.

Firing it up you'll see that it is indeed fast, and it is indeed somewhat spartan. There's only a single panel, which you can scroll with the cursors or Vim (or Emacs) navigation. Use the left arrow or backspace to go to the parent directory. If you're using nnn in a fully fledged desktop environment then opening files (either with the right arrow or enter) will respect your file associations there, via the xdg-open helper.

QUICK TIP
Don't worry too much about memorising keys, they have a habit of changing from version to version. They're always up to date in the help screen, so hit ? if you're puzzled.

Here are a few handy shortcut keys to get you started, you'll find the rest by pressing ?:

~ switch to your home directory
@ switch to directory you launched nnn from
- switch to last visited directory
. show/hide dotfiles
! spawn a shell in the current directory

Nnn supports up to four contexts, which are like tabs with memory (you can set them up to remember settings and locations). Those are the numbers in the corner, the current context (1 if you've just opened nnn) has its number highlighted with a blue background, and other contexts in use are underlined. Switch contexts using keys 1 through 4, you'll see if you navigate somewhere in context 1, then switch to context 2 and navigate to a different place, then you can hop back and forth using the 1 and 2 keys. You can quit a context by pressing q, which will take you to the previous active context. Quitting all the contexts is the same as exiting the program, but you can also do that with a capital Q.

If you wanted to copy files from one directory to another select them with space (or Ctrl-J if you want to be difficult), navigate to the destination (contexts are handy here) and hit p. To move them instead, use v.
To delete them (careful!) press x. You can rename individual files with Ctrl-R. If you select a bunch of them, then press r, then s (for selection), this will open a text file listing their names from whence you can rename them all at once. If no files are selected, then you can rename everything in the current directory this way.

Bring the panes

Conventional and Orthodox file managers are all about multiple panes, or panels or columns or whatever you want to call them.

A logo involving both chess and mathematical notation? Shut up and take... oh, it's free.

Plugins for nnn

Nnn is tiny but highly extensible. There are several plugins available in the Git repo (check out the list at **https://github.com/jarun/nnn/tree/master/plugins**, which also shows their dependencies), and even a script to install them easily. You can run this script directly (but even though it runs as your user it's good practice to check it first) with

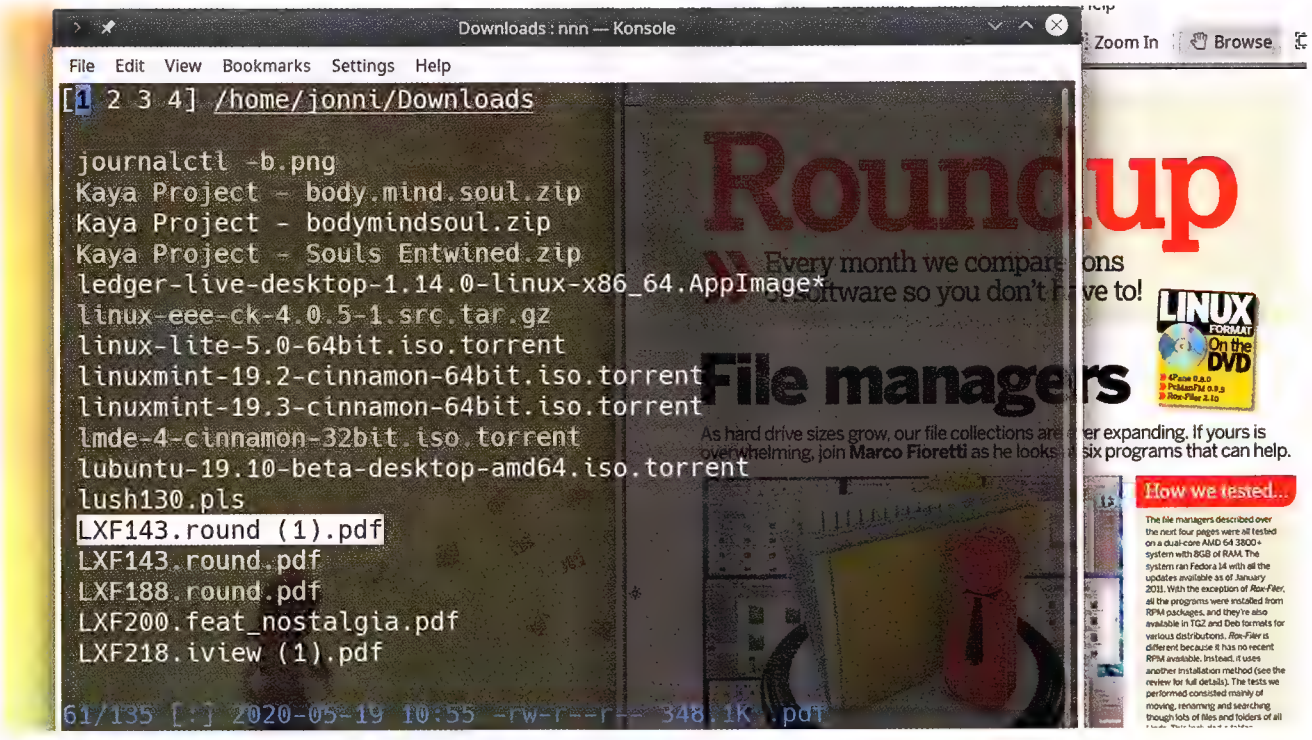
```
curl -Ls https://raw.githubusercontent.com/jarun/nnn/master/plugins/getplugs | sh
```

This will install all the plugins in ~/.config/nnn/plugins. To use them we list them in the NNN_PLUG environment variable, together with a hotkey to invoke them. For example if you've got the mediainfo tool installed (sudo apt install mediainfo), invoke the mediainf plugin (which requires $PAGER to be set too) with:

```
export PAGER=less
export NNN_PLUG='m:mediainf'
```

then start nnn as normal. Now find a media file, hit ; to enter plugin mode, then hit m and you'll see media information. You can make these variables persistent by appending them to your ~/.bashrc file. To use multiple plugins, delimit them with semicolons.

You can write your own plugins in whatever language you like, but for reasons of purity POSIX-compliant shell scripts are preferred. Have a look at the provided ones to learn the ropes. Some of them are quite fun – who would've thought we'd finish this issue reading Gargantua and Pantagruel in a terminal file manager, via Project Gutenberg?



The console in action.

Midnight Commander has two, Ranger has (by default) three and 4Pane has seven (just checking you're paying attention). Nnn has only one. And that's part of its minimal design. However, if you want to run two (or more) instances side by a terminal multiplexer, then it will happily accommodate that. The simplest way is with dvtm, which we can install and invoke with:

```
$ sudo apt install dvtm
$ dvtm nnn nnn
```

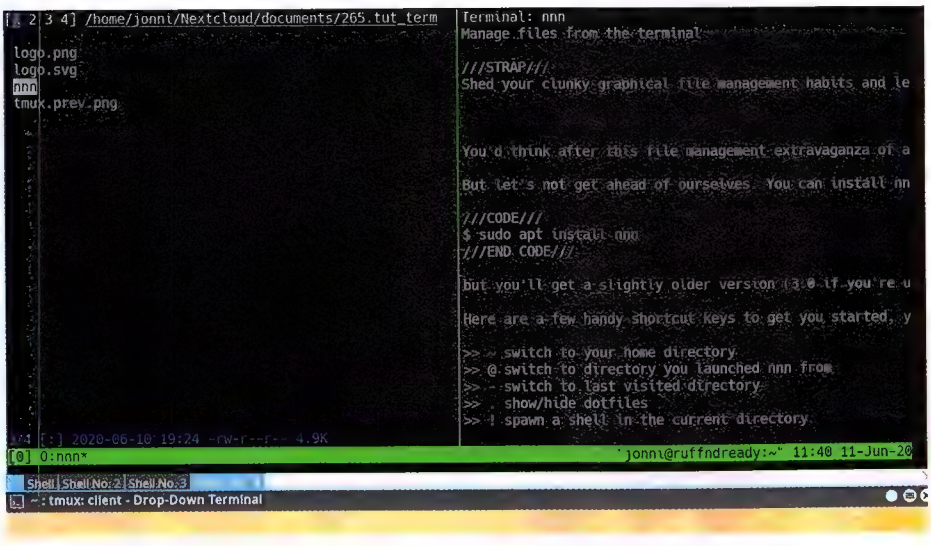
What's really magic about this is that the two instances share buffers and selections and wotnot. You can't recreate traditional file manager functionality (where you navigate directories with the left pane and files with the right), but you can do other cool stuff. You can switch between the two dvtm "windows" using the mouse, or using the modifier key (Mod, which defaults to Ctrl-G) and then the 1 and 2 keys.

The current window has its topbar highlighted in blue. Start a new window with Mod-c and it will tile nicely into the existing arrangement, giving you a handy terminal. You can shrink the current window with Mod-h and enlarge it with Mod-l. Just like a glorious tiling window manager. Windows can be closed with Mod-x.

A number of plugins (see box, opposite) can use a multiplexer too. For example the preview-tui plugin (see **https://github.com/jarun/nnn/blob/master/plugins/preview-tui**) can use tmux or kitty to display in line previews. With a bit of scripting magic (check the wiki) you can use this to obtain live previews of files (if the hot key method described below is too taxing). Alternatively tabbed from Suckless tools can be used to get live previews of videos, images and PDFs via the preview-tabbed plugin.

Multimedia files will open in whatever your desktop tells them to, if you're using a proper desktop. If not, you can set default MIME types with the xdg-mime command. You'll want to install some lightweight viewers, such as sxiv (for images), zathura (for PDFs) and mpv (for videos). To edit a text file (with whatever's set in the $EDITOR variable, or else Vim) navigate to it and press e.

As in Ranger, there's no built-in search functionality. But there is very quick filtering that's available from the / key. So if you know where you're going, hit / and type the first few letters of the directory, navigate with the cursors, then rinse, lather and repeat. You can toggle filtering by regular expressions by hitting / again. But that's a can of worms we probably shouldn't open up here.


[1 2 3 4] /home/jonni/Nextcloud/documents/265.tut_term
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Terminal: nnn
Manage files from the terminal
///STRAP///
Shed your clunky graphical file management habits and le
You'd think after this file management extravaganza of a
But let's not get ahead of ourselves. You can install nn
///CODE///
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///END CODE///
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>> ! spawn a shell in the current directory
[0] 0:nnn*
jonni@ruffndready:~" 11:40 11-Jun-20
Shell | Shell No:2 | Shell No:3
~ : tmux: client - Drop-Down Terminal

A preview of this very document, courtesy of some weird, inception-like terminal multiplexing.

Create stop-motion animation with your Pi

Les Pounder shows us how to film the latest animated blockbuster using the humble Raspberry Pi, a LEGO model and a bit of imagination...

Wallace and Gromit, *Morph*, the evil skeletons created by Ray Harryhausen... these are all famous examples of an animation technique called stop-motion, which uses individual images posed by an animator so that when run as a sequence, the subject appears to move. Traditionally this takes many hours or days of painstaking work. But using the power of the Raspberry Pi and its camera, we can make our own movie studio. In this tutorial we shall make a short animation using a LEGO model, all filmed using Python and the Raspberry Pi.

The button that triggers our camera is a push button inserted into a breadboard. This is then connected to GPIO pin 17, and GND. See the diagram in the download for this project for connection details (*see also right*).

The Raspberry Pi Camera now comes in many different variations, ranging from the V1 camera and its fixed focus lens to the latest High Quality Camera and its interchangeable lenses. They all connect to the camera port of the Raspberry Pi, located just behind the Ethernet and USB ports. Open the camera port by gently lifting the plastic lock upwards, then insert the ribbon connector with the blue tab facing the USB and Ethernet ports. Close the lock on the connector and give it a gentle pull to make sure it's in place.

YOU NEED
- Raspberry Pi 4 or 3B+
- Raspberry Pi Camera
- Raspbian
- A breadboard
- 2x Female to male wires
- 1x Push button (Momentary switch)
- Code: **https://github.com/lesp/LXF264-Stop-Motion/archive/master.zip**

Using a semi transparent preview window, we can frame our shot and watch out for any errors. To take a shot we press the push button and capture a frame of animation.

Power up your Raspberry Pi and then go to Preferences > Raspberry Pi Configuration. Under the Interfaces tab click the Enable button for the Camera. Then click OK and reboot the Pi.

With the Pi rebooted we can now test the camera. Open a Terminal and type the following command to take a quick picture:

```
$ raspistill -o test.jpg
```

A preview window should appear, giving us five seconds to frame the shot before the image is saved to disk as test.jpg. We can take a look at the image using the file manager. If there are any issues, go back and check that your camera is properly connected and the camera interface is enabled.

Coding the project

The code for this project is written in Python, and the default editor for Python is now *Thonny*, found in the Programming menu. The first three lines of code are where we import modules of pre-written code. This enables our project to use the GPIO to create a push button trigger, use the camera and prevents our code from exiting:

```
from gpiozero import Button
from picamera import PiCamera
from signal import pause
```

Next, we create a global variable – one that can be used outside and inside a function. We need this to create a variable called order ,which will be used to number the images as we press the button:

```
global order
```

The next two lines create objects that enable our code to interact: first, with our push button connected to GPIO 17, and second, with the Pi camera:

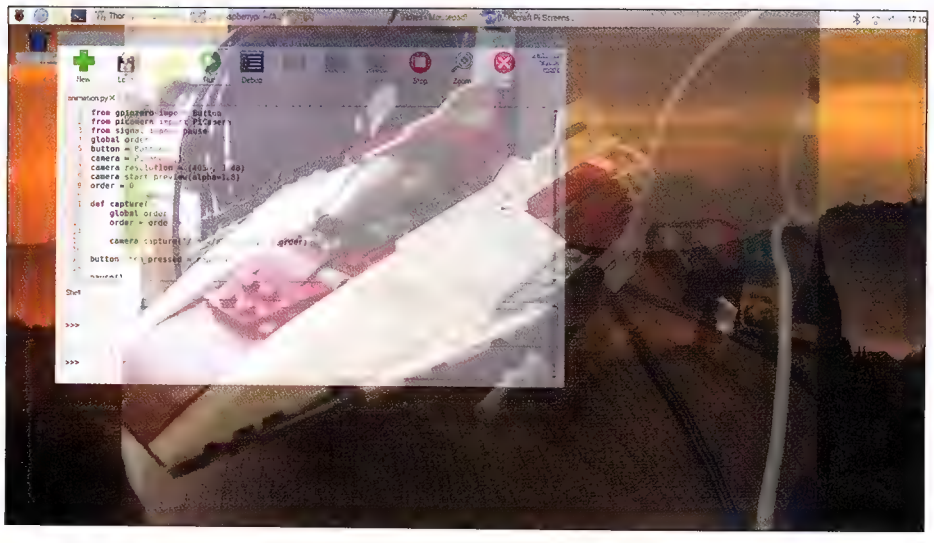
```
button = Button(17)
camera = PiCamera()
```

To set the resolution of the images we call the camera object and then specify a resolution as a tuple. In our project we used the new High Quality Camera, and at the time of writing this has a small problem with images smaller than the maximum resolution, hence it's been set to maximum. If you're using an older Pi camera, then please change this to match your requirements, say (1024, 768). But HQ camera users, please set this to (4056, 3040) until the issue is fixed.

```
camera.resolution = (4056, 3040)
```

The last two lines in this section of code will start a preview window, giving us the chance to see what the camera sees, and enabling us to frame the shot accordingly. We alter the transparency of the preview window using alpha and set this to 128, which is approximately 50 percent transparency. We do this so that we can still see the *Thonny* application window, in case there are any errors. The last line sets our order variable to 0 and this will enable our image filenames to start fresh each time the code is run.

```
camera.start_preview(alpha=128)
order = 0
```



Next, we now create a function called capture . This is the code that's run each time the button is pressed. Functions are given a name, called "defining a function" and any code that's run when the function is called is indented to show that. Our function uses the global variable order and we update the value of that variable by incrementing the value by 1, each time the button is pressed. Then we call the camera.capture to take the picture. The filename of the image is set to /home/pi and the % places the contents of the order variable as a string at this point in the text:

```
def capture():
    global order
    order = order + 1
    camera.capture('/home/
pi/%s.jpg' % order)
```

The final lines of Python code are our button trigger, which when pressed will launch the function that we have just created. Then the code will pause, preventing the code from exiting, and forcing it to wait for more button presses:

```
button.when_pressed =
capture
pause()
```

Save the code as animation.py and click Run to start. You should see a ghostly image appear over the top of the desktop. This is a live preview that we can use to frame our shots. Now is the time to get some LEGO bricks, toy cars or modelling clay and make a scene. When you're ready, press the push button to take a picture, then move the items a little, take another picture and repeat until you're done. To stop the code, press the Stop button in *Thonny*.

You should now have a series of images in /home/pi that are numbered from 1. Create a new folder called animation and move the images to there. To convert these JPEG images into an animated GIF, we need to install some software. In a Terminal type the following to install *ImageMagick*, which is a great tool to manipulate images from the Terminal:

```
$ sudo apt install imagemagick
```

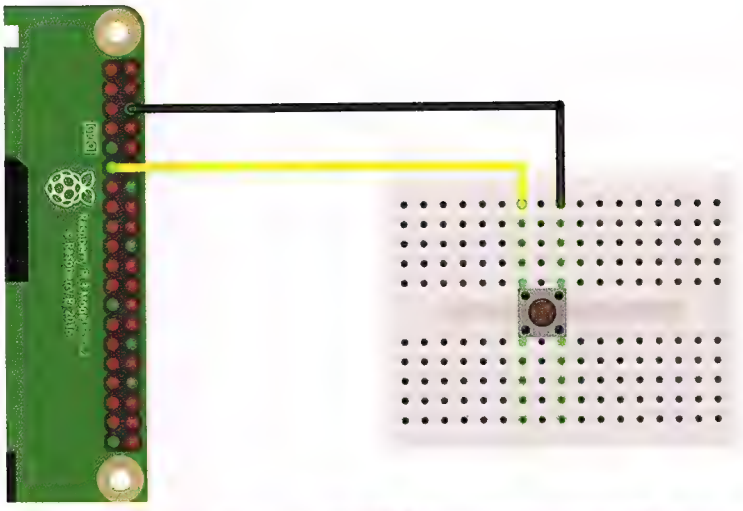
In the terminal navigate to the animation folder.

```
$ cd animation
```

Next, use *ImageMagick* to convert the images into an animated GIF. We use the convert command and set a delay to 1/10th of a second (100ms). The image will infinitely loop if we set the number of loops to 0. Then we tell the command to use all of the JPEGs in the folder, and the output file is to be called animation.gif:

```
$ convert -delay 10 -loop 0 *.
jpg animation.gif
```

The process will take some time, but when complete, open a web browser, and drop the animation.gif file from the file manager on to the browser. The image will load and you'll see the animation play in the browser. Don't stop there – build a bigger project with your materials and figures, and bring it to life, too! ■



The GPIO17 pin is pulled high by our code, and when the button is pressed it's pulled to GND, causing the pin to go low.

Here's a single frame from our animation. The LEGO minifigure and Star Wars spaceship are moved slightly in each frame, and when run as an animation they appear to move.

QUICK TIP

If you receive an error when creating the animation with imagemagick, fear not! We traced the issue to /etc/ImageMagick-6/policy.xml and we have included a fixed version in the download. Just copy ours over and everything is fixed.

Raspberry Pi High Quality Camera

The new Raspberry Pi High Quality Camera is fantastic. It may cost much more than the standard camera, but it uses interchangeable lenses (bought separately). We can also use old C and CS mount lenses, or other lenses via adaptors. A proper aluminium screw mount provides a solid fitting to secure our camera to a tripod. The new camera connects to all models of Pi with a Camera connector, including later models of the Pi Zero via an adapter cable. It can be controlled using Python, as we did in this tutorial, and it can be used directly via the raspistill and raspivid commands in the Terminal.

But what makes the latest camera so different to those before it is that there's so much manual control. We can alter the focus and light levels to get the best shot. We can use the camera as a webcam for video calls to friends and family. The new camera starts at$95 with no lens, and a 6mm wide angle lens is around $50. A 16mm telephoto lens costs around $95 and both of these lenses provide crisp optics for the Sony IMX477R 12.3 megapixel sensor.

PSU 202: Understanding Power Factor Correction

Darren Yates continues his short series on PC power supply units, this month looking at the concept of real power versus apparent power, plus a strawberry milkshake.

One feature you'll see advertised on many PSUs is 'Power Factor Correction' or 'PFC'. It's long been mandatory on PC PSUs in the EU and U.S. and for the sake of the planet, PFC is actually important. However, you might also read it can save you money. Like most things, it's not that simple, so this month, we're diving into some electrical theory to understand just what PFC is, why it's in your PSU and what difference it makes.

Real power vs apparent power

We've said it before, but for those late to class, a PSU converts the AC mains voltage into DC voltage sources or 'rails' that power your PC's components. Each rail supplies electrical current and if you multiply the current for a rail (measured in amps) with its rail voltage (volts), you get the electrical power (watts) that rail can supply. Add up this power rating for each rail in the PSU and you get the total power rating of the PSU in watts you see stamped on the box, whether its 450-watts, 650 or whatever.

This power is also known as 'real' or 'true' power, as its power that does actual work – in this case, powering your PC. However, there's also another type of power known as 'apparent power'. This is the power the power generation companies have to supply to your mains socket in order for your PSU to power your PC.

But hey, isn't that the same thing? No, not quite. A PSU is what's called an 'inductive' electrical load. When converting AC power into DC power, some of the AC power is temporarily stored within a component called a 'transformer'. This is essentially two or more windings of wire wound around a small block of thin laminated steel plates.

This stored power quickly returns to the AC mains socket, but it changes the relationship or 'phase' between the voltage and current. This change creates 'reactive power'. Add together the 'real power' your PC uses with this additional 'reactive power' and you get the 'apparent power' the power generation companies have to supply you.

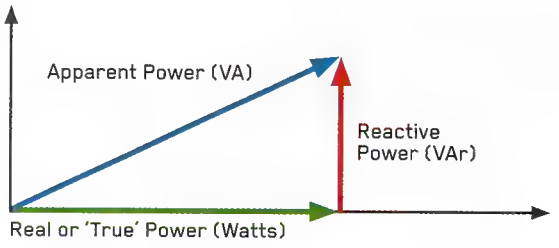
Don't laugh, but an easier way to explain it is usually with a glass of a certain alcoholic amber fluid, but as this is a family show, we've come up with our deluxe 'electrical power milkshake' diagram instead. The real power in your milkshake is the actual milk – that's what you're paying for. The reactive power is the froth on top that, while a bit of fun, isn't really useful to you. Finally, the apparent power is the whole milkshake glass.

If you can stand just a little more theory, you can look at real, reactive and apparent power as a right-angle triangle – with real power, the voltage and current are 'in-phase', whereas reactive power will have the voltage and current 90-degrees 'out-of-phase'. Apparent power takes into account this phase change created by the reactive power.

So what's 'power factor'?

If you divide the real power the PSU delivers to your PC by the apparent power the PSU takes out of the AC wall socket, you get what's called the 'power factor' (PF) of that PSU. The ideal power factor is '1.0' – this is good for everyone, since the power station only has to generate what you'll actually use. However, if your PSU also needs a certain amount of reactive power, let's say 20%, you may use 400-watts of true power, but the power station has to supply you 500 AC-watts or VA ('volts-amps') to overcome the 20% reactive power loading.

Given there are now minimum PF levels required for all PC PSUs, they all include what's called 'Power Factor Correction' (PFC). There are two kinds – passive-PFC and active-PFC. Passive-PFC uses 'passive' components (capacitors) to negate the reactive-power



Reactive power occurs when the voltage and current are out-of-phase.

Below Left: The Power-Mate Lite power meter measures power factor (and much more).

Below Right: Good low-cost retail power meters for home use will measure power factor.

component, while active-PFC uses 'active' components (transistors) to do a better job. Active-PFC gets nearer the magic 1.0 mark (usually better than 0.9), but also costs more.

How to measure Power Factor

If you need to measure power factor, the simplest way is to use a decent AC mains power meter. You'll find good home models under $30 should do the job. For more serious work, heavier-grade meters, such as the 'Power-Mate' units, sell from $130. You'll typically find PF varies with load, with higher loads giving better PF.

Does having PFC save you money?

The short answer to this is 'go find your last electricity bill'. If you pay your electricity in cents-per-kilowatt-hour (c/kWh), then no, PFC won't help you much. However, if you pay a portion in cents-per-kilo-volts-amps (c/kVA), then yes, PFC could save you money.

As far as we can tell, Australian electricity retailers only charge domestic users for the real power (c/kWh) they use, not apparent power (c/kVA). However, many commercial businesses are charged for apparent power. So, if you run a business in commercial premises and you pay for apparent power, a PSU with a higher power factor should help lower your electricity bill for that PSU power, by the proportion its PF is improved.

If your next question is 'how much can I save', that's too complex for us to answer. Essentially, it depends on the change in power factor and the real power your PCs consume. The more real power you consume and the greater the PF using an active-PFC PSU, then the more you will likely save. But remember – you must be currently paying for apparent power for PFC to be of any benefit.

Actually, that's not strictly true. In an altruistic sense, as we showed before, PFC helps everyone, especially the electricity generators. The more we can reduce reactive power, the more we can reduce the total power generation capacity. That could lead to smaller, cheaper generators, less power wastage through the transmission grid system and less greenhouse emissions. Electricity suppliers are also known to offer PFC units to big industrial and commercial users to improve power factor and reduce kVA costs.

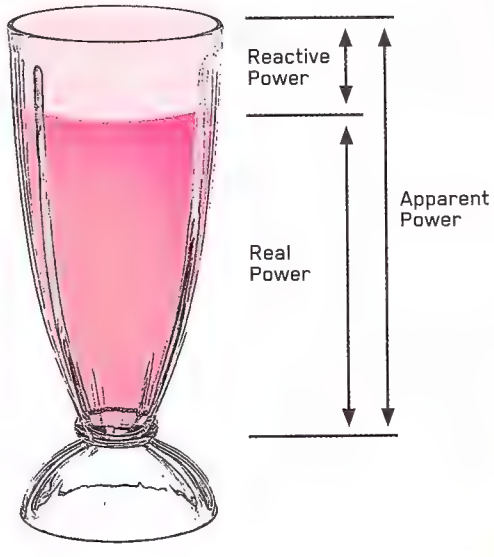
CoolerMaster's MWE 750 Gold has Active Power Factor Correction (AFPC).

PFC is important

One PSU with low PF won't sound like much, but if you have 10 million PCs with a low-PF PSU, it can add up to a sizeable amount of extra power generation required. Whether it makes a direct difference to your hip pocket depends on whether or not you pay for apparent power. Most good PSUs will offer active-PFC, but now you should have a better idea of what it means, what it does and why it's not bad to have it on your next PSU.

"If your next question is 'how much can I save', that's too complex for us to answer. Essentially, it depends on the change in power factor and the real power your PCs consume."

Power Factor = Real Power / Apparent Power



Real Power is the milk in your milkshake, reactive power is the froth on top.

One third of in-development games affected by pandemic

In a survey conducted by the Game Developers Conference, 33 percent of surveyed developers revealed that the project they're working on has been delayed due to the ongoing COVID-19 pandemic. The reasons are fairly obvious: game studios the world over have been transitioning to a work from home model, which has its teething problems. According to the survey, 70 percent of developers are now working from home.

Reasons cited for the detrimental effect of working from home include access to necessary hardware, which could include expensive console development kits. Given that many studios may be working on games for the next generation of consoles, and given how highly sensitive access to those dev kits are, it's understandable. Also cited was "ambient stress" which is something we're all probably feeling: general loss of productivity due to how scary the circumstances are.

Xbox eyes *Batman: Arkham* studio Rocksteady and the rest of WB Games for purchase

AT&T has reportedly been considering selling off Warner Bros. Interactive Entertainment. According to a new report from The Information, Microsoft has emerged as a new potential buyer for the division. If Microsoft does end up making the purchase, that could place well-established studios such as Arkham's Rocksteady, *Mortal Kombat*'s NetherRealm, Lego's TT Games, and *Middle-earth: Shadow of War*'s Monolith as the newest Xbox Game Studios.

GAMING NEWS

Rocket League ditches Steam, goes free-to-play

New owner Epic Games finally plays its hand.

When *Fortnite* company Epic Games purchased *Rocket League* studio Psyonix last year it seemed almost inevitable that the game would drop off Steam and move exclusively to Epic Games' own PC gaming storefront. Surprisingly, it didn't, but now it will: *Rocket League* is going free-to-play and it can no longer be purchased on Steam.

Those who already own the game on Steam will still get updates, and will not lose any of the important features and online compatibility. But for those diving into the game from now on, it'll only be available from the Epic Games Store.

The game will also be free-to-play on PlayStation, Xbox and Nintendo consoles.

Source code for the SNES version of *Doom* has been released

See how the one-man made 'impossible' port came to exist.

The Super Nintendo version of *Doom* is a true wonder. Released two years after the original PC game, the port eschewed id Software's Doom engine entirely. Head programmer Randal Linden instead built a whole new game engine (Reality) in order to get the game running on a 16-bit console with severe memory and storage limitations.

Sacrifices were inevitably made, as was the case with most console ports of *Doom* in the '90s. Floor and ceiling textures were absent, with a single colour as replacement (though skyboxes are intact). Elsewhere, some levels are missing owing to storage limitations, and enemy models are lacking quite a few sprites, to the extent that you'll never see their backs.

But, it's *Doom* on a 16-bit console, and bizarrely it supported two-player deathmatch via an XBAND modem. For anyone curious about this technical masterstroke, Randal Linden has released the port's source code on Github (search for Randal Linden on Github). It's brilliant to have access to the code for posterity, but who knows... maybe we'll see some brand new SNES FPS games?

Mafia Definitive Edition release pushed to September

The 2002 game has been completely rebuilt – but that takes time...

The *Mafia Definitive Edition* release date has been pushed back nearly a month due to the ongoing COVID-19 pandemic.

According to an official statement from the team at 2K, the ground-up rebuild will release on September 25 instead of the original planned date of August 28. As many game developers have acknowledged, the COVID-19 pandemic and the work-from-home model it has produced can complicate the dev process – in this case, 2K writes that finalising everything in time for the original launch date has become "increasingly challenging."

"From the beginning, this has been a passion project for us," the statement reads. "Many of our developers helped create the original *Mafia*, and all of us are committed to crafting an updated experience worthy of that timeless classic. We appreciate your patience and understanding as we make *Mafia: Definitive Edition* the very best it can be for all our fans worldwide."

Mafia: Definitive Edition will launch on PS4, Xbox One, and PC and plunge you back into the world of Lost Heaven and the life of cabbie Thomas Angelo, who gets involved with the mafia.

EPOS is the new name of Sennheiser gaming audio – and we can expect big things

While one new gaming audio company enters the fray, they bring the unique advantage of incorporating a well-known player into their fold too.

EPOS, a new Danish audio company dedicated to the creation of high-end audio equipment for gaming, has just announced a new global gaming campaign that folds in a familiar name in the gaming audio space.

The crucial factor here – as well as the launch of a new gaming-focused audio company, which is always good to see – is that Sennheiser's gaming portfolio will be folded into EPOS. The new moniker under which we'll see Sennheiser gaming audio products will now be the dual-named 'EPOS | Sennheiser' mantle.

Thus, as well as being the new branding of Sennheiser gaming headsets going forward, the expertise brought to EPOS through Sennheiser means that there is a good opportunity to build upon the gaming audio reputation that Sennheiser has already attained, while also introducing an exceptional new portfolio of premium EPOS branded products.

Sennheiser gaming headsets have been consistently one of the top performers of recent years - despite often having large price tags, they often go a long way to justifying them.

PUBG has sold 70 million copies

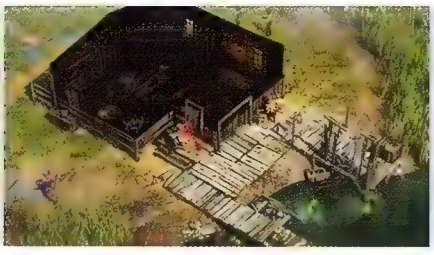
Just over three years after it launched, PUBG has sold 70 million copies. That's excluding the very popular mobile version: the 70 million figure applies to the PC, Xbox One and PS4 versions combined, according to GamesIndustry.biz.

Naturally, the pace of sales has slowed since its Early Access debut in early 2017 – PUBG Corp reported 50 million sales in June 2018. But in an age of very powerful free-to-play competitors like *Fortnite* and *Apex Legends*, it's not shabby at all, and despite losing the battle royale spotlight it's community is thriving.

The shooter's mobile version is faring well, arguably better: as of June last year it had amassed 400 million downloads, with 50 million daily active users.

A new Xbox controller has been designed for playing Project xCloud on your mobile

The SN30 Pro Gamepad, made by 8Bitdo, (first spotted by The Verge) will work with Android phones, is Bluetooth enabled, and has a reported battery life of 18 hours. It also comes with a handy clip so you can nestle your smartphone above the controller pretty easily. Pre-orders are already live on Amazon, with the controller due to launch on 21 September 2020. ■



$84.95 | desperadosgame.com | PC, PS4, XB1

Desperados III

Grab your stetson and sneak your way through the Wild West.

Though it's a prequel to 2001's *Desperados: Wanted Dead or Alive*, *Desperados III* is really *Shadow Tactics: Blades of the Shogun*'s successor. Like Mimimi Games' last real-time tactical stealth affair, it's got smart – but not too smart – enemies, intricate maps overflowing with opportunities for cleverly orchestrated murder and, if you fancy it, some mayhem, a quintet of proficient killers and sneaks, and best-in-the-business vision cones. As one of the greatest stealth games of the last decade, the Edo-era romp is a tough act to follow, but its Wild West cousin looks to some other great stealth games for inspiration.

A few missions take place in civil zones where you're free to explore most of the map without drawing attention to yourself. While out for a stroll, you can listen in on conversations to get clues, helping you identify your targets or find ways to kill them. It's social stealth very much in the same vein as the *Hitman* games, but only the bare essentials. Rather than taking you down an elaborate path, the clues are more like 'there's a loose sign hanging above that guy's head' and you'll still spend most of the mission sneaking and killing your way through off-limits areas full of guards.

The combination of plentiful firearms, lots of ammo crates, and the ability to pause the action means you can just drop the pretence of stealth and go in guns blazing if you want to, welcoming the alarms and turning it into more of a tactical shooter. Even if you prefer to be sneaky and creative, it's reassuring to have the option to shoot your way out of trouble in your back pocket. Guns can become a bit of a crutch, however, letting you brute force your way through some of the game's puzzles, but ammo is one of several elements that can be tweaked at the start of every mission. If you're after more of a challenge, you can use these options to turn it into a pure, unforgiving stealth game.

Everything's bigger than in *Shadow Tactics* – maps, enemy numbers, combat ranges, explosions. There are more obstacles – so many obstacles – but just as many tools to deal with them. It's full of astonishingly complex clockwork dioramas – again calling the recent Hitman games to mind – but *Desperados III* does rely a bit too much on its scale and overwhelming numbers to create its challenges. Early on there's a mission where you're defending a small farmhouse from an attack, for instance, but instead of focusing on that one location, it's spread out across a large area, where you once again have to kill and sneak past an entire army to progress through the level.

Desperados III is bigger, more boisterous and a bit less elegant than *Shadow Tactics*, but maybe that's fitting for a game about rough-and-tumble gunslingers and outlaws.

FRASER BROWN

Turns the Wild West into a brilliant tactical playground that will fill you with lead over and over again.

★★★★☆

$28.95 | westofdead.com | PC, PS4, XB1, Switch

West of Dead

Exploring the Frontiersman's afterlife.

West of Dead's combat marries twin-stick shooting to a cover system, and throws in a few extra tactical wrinkles like lights in some rooms that stun nearby enemies and loot charms that might, say, halve your reload time or recover some health if you manage to dive into cover soon after taking the hit.

My first two or three runs in the Crypts felt like stumbling disasters, but gradually the pace and nuance of the combat started to sink in. I noticed exactly how many hits it took from my six-shooter to stun gun-toting enemies, and how many shots from them it took to destroy the cover I tended to cower behind. I realised that the zombie-like melee foes tended to follow you back into the previous corridor, where they're easier to takedown.

West of Dead is brilliant at telegraphing every small detail of combat, from the moment an enemy's alerted to your presence to the moment they've locked their aim on you and only a frame-perfect dodge roll will stop you taking damage if you're not behind cover. When all the timings permeate, you start to play reflexively, rather than consciously. You're always in cover, always aware of how many empty chambers are in each gun, always looking for the next safe place to roll into.

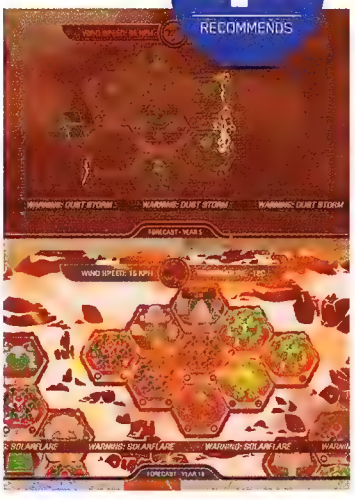
If *West of Dead*'s combat wasn't sewn so artfully into that enigmatic world, though, it wouldn't be anything like as easy to hit 'New Run' after another heartbreaker down the Mines. The visuals are arresting, and appear to be true cel-shaded, from objects to lighting. Hearing Hellboy's voice while you're inhabiting a shadowy underworld of inky black outlines feels very Mike Mignola, and the sombre guitar lines, circling crows, and whiskey-gargling voiceover build a genuine sense of atmosphere.

Other games have explored the same themes and mechanics as *West of Dead*, but rarely has it all come together with such cohesion. The fight's always fair in here, however difficult it may be, and it always feels like you're enduring it for a reason.

PHIL IWANIUK

A fine balancing act of challenge and intrigue, with stabiliser wheels c/o Ron Perlman's voice.

★★★★½



Free | redplanetfarming.com

PC, Linux, Mac

Red Planet Farming

Grow veggies on Mars.

Mars is not the best place to grow a cabbage, but needs must in a world in which humanity has finally made camp on the red planet. That's the premise of *Red Planet Farming*, which puts you in the role of agricultural director for Mars. You're not expanding the Martian outposts, instead you're claiming empty plots, planting potatoes and beans and whatnot, and trying your hardest to keep them alive, year by year.

In a sense, this is the city-builder as a turn-based puzzle game. Across a series of outposts, you have to grow a steadily increasing amount of food, while managing the needs of your chosen vegetables, and local hazards including cold snaps, meteor strikes, and, er, Mars quakes. After every year, your population will (hopefully) increase rather than plummet, while new seeds, technologies and hazards will be gradually introduced. When you've improved your first outpost, you'll be invited to manage another, on a less comfortable region of Mars. Each level brings a new environment with its own tougher challenges to overcome.

TOM SYKES

A smartly streamlined building game where the knife-edge nature of planetary settlement still comes across.

★★★★☆

Free | bit.ly/2AvhRLw | PC, Linux, Mac

Helltaker

Hell is full of block puzzles.

Your goal in *Helltaker* is to amass a 'harem of demon girls', by delving down through the layers of Hell. It's a potentially dodgy premise, but surprisingly OK in its execution, as the women aren't really sexualised, and will tag along for their own reasons.

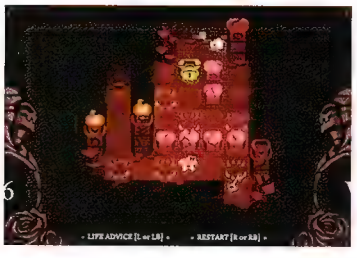
With a limited number of moves, you have to collect a key and reach a lock on each stage, while avoiding timed traps and bashing any skeletons that stand in your way. After clearing a level, you also have to make the correct (not really obvious) dialogue option, or else you have to play the damned thing again.

While it's refreshing for a turn-based puzzler to be given such a lavish presentation, when it comes to its mechanics, Helltaker is a little uninspired and lacking in features compared to the best the genre has to offer – I've been spoiled by *PuzzleScript*'s undo feature, essentially. To an extent, it makes up for it with its puzzles, and colourful cast of characters, but this still feels like an odd mash-up that doesn't really excel in any area.

TOM SYKES

Give it a pass unless you feel like being punished.

★★★☆☆



apc RECOMMENDS

$29.99 | atlus.com | PC, PS Vita

Persona 4 Golden

This JRPG favourite has aged like a fine malt.

Starting a new school is a difficult time for anyone. But the teenaged protagonist of Atlus's sprawling JRPG has it particularly tough. Having moved from the bustle and bright lights of Tokyo to the supposed rural calm of Inaba, he's barely unpacked his bags before a series of gruesome murders shocks the sleepy town. So he bands together with a group of classmates, each holding supernatural powers, to investigate this disturbing phenomenon.

First impressions aren't especially promising. This is, after all, a port of a port: it's based on the eight-year-old PS Vita version, which was a refined edition of the 2008 PS2 original. As such, it's showing its age visually, even if strong art design mostly compensates for its technical shortcomings. And it's still a slow starter: Golden streamlines the original's infamously languid introduction, but it's still a good couple of hours before the training wheels come off and you're given full control. You'll need a bit of patience before you get to see what makes the game so very special.

Eventually, you'll be able to decide exactly what you do outside school hours, and it's not long before you'll be spoilt for choice. The game sometimes follows you into lessons, where you'll be invited to answer a multiple-choice question for small boosts to your character's social qualities.

Each time one of your peers disappears, you have several days to prepare to save them before they're gone forever. For each rescue attempt, you'll venture inside a shadow world which is accessed through a television set. Here, you'll explore rooms and corridors of multi-floor mansions, attacking patrolling shadows that transform into a range of outlandish creatures to be fought in turn-based combat.

Combat is brisk and engaging without being especially innovative. Targeting an opponent's elemental weakness lets you take another shot at them, while you can encourage your party to pile onto downed enemies. It may be getting on a bit, but the belated arrival on PC of one of the finest contemporary JRPGs is extremely welcome.

CHRIS SCHILLING

A bare-bones refit, but this remains a captivating JRPG, marrying drama with stylish demon battling.

★★★★☆

Free | playcrucible.com | PC

Crucible

Nothing can redeem its boring gameplay and poor frame rate.

Checking all of the boxes needed to fit into the service game climate Crucible has: a roster of heroes with diverse abilities, cosmetics, a battle pass with dozens of progression levels, and snippets of lore that suggest a larger world. Unfortunately, it wraps these familiar elements around a competitive third-person shooter that isn't very good. Even for a free-to-play game, I can't find a reason to stick with its boring combat and spotty performance.

So much of *Crucible* feels like a misguided effort, starting with its game modes. Heart of the Hive is a 4v4 race to farm Essence (experience points) and be the first to collect three hive hearts. Efficient farming is the best way to out- level opponents and get an edge in fights, but it's so boring that I can't blame most of my teammates for screwing around instead of aiming for the objective. I had a bit more fun in *Crucible*'s duos-only 18-player battle royale mode, Alpha Hunters. The map still feels too big for the number of players, but the action does tend to kick off faster than Heart of the Hive. There's also a neat twist – players that have lost their partner can offer to partner up with enemy players and reform a duo on-the-fly.

Crucible's combat is sluggish and the gluttony of explosion effects are hard to read up close. Imposing assault rifles and miniguns sound like they're shooting marbles. Neither NPC or players react to taking damage, something that totally kills the impact of Drakahl's big axe and Shakirri's sword.Since most weapons are only effective at mid-range and movement is slow, every shootout becomes two people staring at each other holding left click, each trying to drain the other's massive health bar first.

There are too many shooters out there that do what *Crucible* does better. That's a big problem for a competitive multiplayer game, even at the low price of free.

MORGAN PARK

Despite some cool heroes and a neat twist on battle royale, Amazon's hero shooter wasn't worth the wait.

★★☆☆☆

Free | grahfmetal.itch.io | PC

Spectacle

A sight for sore eyes.

Spectacle, like its sci-fi predecessor Infested, is an adventure game inspired by the old 'MacVenture' series, where first-person puzzles and gory deaths lurked round nearly every corner. As you might expect, it's an old-fashioned game, with one or two dated quirks – but it's also ambitious, huge, and somehow free.

You play as a traveller from Earth who becomes trapped in a fantasy world, after running into a sinister magician. To get home, you'll need to stuff your pockets with items, and your head with magical spells – before bashing that head against heaps of difficult puzzles. You remember the old adventure games, before every verb was compressed to 'use', and all the unfair dead ends were sanded away? *Spectacle* adds them back in, but in a way that, largely, works. There are a load of grisly deaths to discover, from snake attacks to deadly traps. Where *Spectacle* excels is with its whimsical, Middle-East-themed fantasy world, which is brought to life with pixel art and chiptunes. There's a lot of, well, spectacle crammed into the game world, from those enjoyable monster encounters, to a handful of impressive set-pieces.

TOM SYKES

Spectacle does more than enough to escape its shadow.

★★★★☆■

DEVELOPER CREATIVE ASSEMBLY **PUBLISHER** SEGA **RELEASED** 2014 **WEB** ALIENISOLATION.COM

Alien: Isolation

Tom Senior flashes back to a terrifying audiovisual masterpiece.

Alien's Xenomorph is one of cinema's best known monsters, but at what point does the creature become boring? The comics and movies that rose to feed *Alien*'s hungry fandom have reduced the creature to a cartoon villain. The Xenomorph has battled Batman, Superman, and the Predator. What do you do with a monster that the audience has seen so often?

You hide it. *Alien: Isolation*'s Xenomorph hunts in the ship's vents, waiting to drop down on its prey. Directional sound cues hint at its presence, creating excruciating paranoia. Was that clunk some pneumatic operation of the space station? Or the creature moving just above the ceiling panels? Then, when the monster finally descends it uncoils gracefully, enormous and utterly terrifying.

Creative Assembly chose to adapt the Xenomorph from the very first film, before it became a drone in a hive army. This thing is eight feet tall, and you can tell from the thudding of its footsteps that it's heavy. That gives you a clue as to where it is, which is useful as a player, but it also sells the monster's power. The first time you actually see the thing is a remarkable moment in PC gaming, and it marks the beginning of a sweaty 15-hour game of hide and seek that becomes more hellish with every passing hour.

Above its station

You play as Amanda Ripley, daughter of Ellen Ripley from the first few films. You travel to the Sevastopol space station to recover the flight recorder of the doomed Nostromo from the original Alien movie. The space station has descended into chaos. A single alien's campaign of terror leaves the crew surviving in pockets, being picked off one by one.

It's hard to believe that *Alien: Isolation* is six years old. The station is beautifully modelled, and displays huge respect and understanding of the source material. The smooth padded bulkheads of the communal areas contrast with the harsh industrial corridors in the guts of the vessel. Important areas have the optimistic sheen of excitable '60s science fiction spaceships, emulating the Mother hub in the original *Alien* film. You spend most of your time going cautiously through dimly lit engineering corridors, clad in dark grates and backlit fans.

The utilitarian architecture of these vessels express *Alien*'s pessimistic vision of the future, in which employees are contractually obliged to maintain titanic vessels to generate profit they will never see. The Sevastapol's terminal messages expose contractual disagreements and management squabbles, and an organisation

that can barely come to accept that the universe's deadliest predator is on board – people are disappearing, but they fret about the next shipment going late.

It's good worldbuilding. What makes *Alien: Isolation* exceptional is that it applies the same thorough devotion to authenticity to every aspect of the game. The retrofuturistic computer interfaces are completely right for the universe, but also serve as beautiful little works of art all by themselves. The UI draws influence from the simple glowing green forms you see on the scanner from *Alien*. The UI and screen interfaces distort and flicker as though they're being displayed through an old cathode ray tube display that's nearing its end. It's perfect for a world where futuristic technology has been cobbled together from parts that are designed to function at bare minimum capacity.

Film studies

Every animator, artist, designer, writer and composer has to be pointing in the same direction to achieve such a unified and tone-perfect aesthetic. Audiovisually, the game is mostly interested in recreating *Alien* as a cinematic object. Post processing effects are used to create visual distortion to mimic late '70s film stock. Chromatic aberration creates the impression that you're looking at the world through the lens of the camera, rather than through the eyes of the character. Film grain and acutely observed lens flare complete the effect.

I often dislike these effects because they can create a distancing effect between me and the game world. I'm watching the game through a host of visual filters designed to mimic defunct imperfections in old movie cameras – today's digital cameras happily capture super high definition images without distortion, and directors like JJ Abrams have actually added lensflare in to dazzle the viewer.

These techniques made no sense in *The Witcher 3*, for example, but I forgive *Alien: Isolation* because its mission is to recapture the look of the 1979 movie. Those effects are part of the texture of that world. Anything else would look too clean, too neat.

I also forgive it because it's an innovative horror game in its own right. Without the *Alien* licence there's plenty to praise about a game that puts so much effort into its monster AI. The Alien is a responsive nemesis that adapts to your preferred methods of evading it. Once it has found you in a closet, it will start checking closets. You might get used to hiding under tables only to be terrified when it learns to explore there. Watch, too, for the dripping of saliva from an overhead vent. Many times I have been caught wandering towards my next objective only to be swept up by the creature's claws.

Sound is important too. There are small guns in the game, but you'd be a fool to use them One gunshot will draw the Alien from any corner of the level. Be careful when sneaking around, because if you knock something over and the Alien is near, it will come to explore.

At points the terror can turn to frustration, as though the whole game is a repetitive series of trial-and-error scenarios. The game received a wide range of scores at release, and I would attribute most of the dissatisfaction to Isolation's save

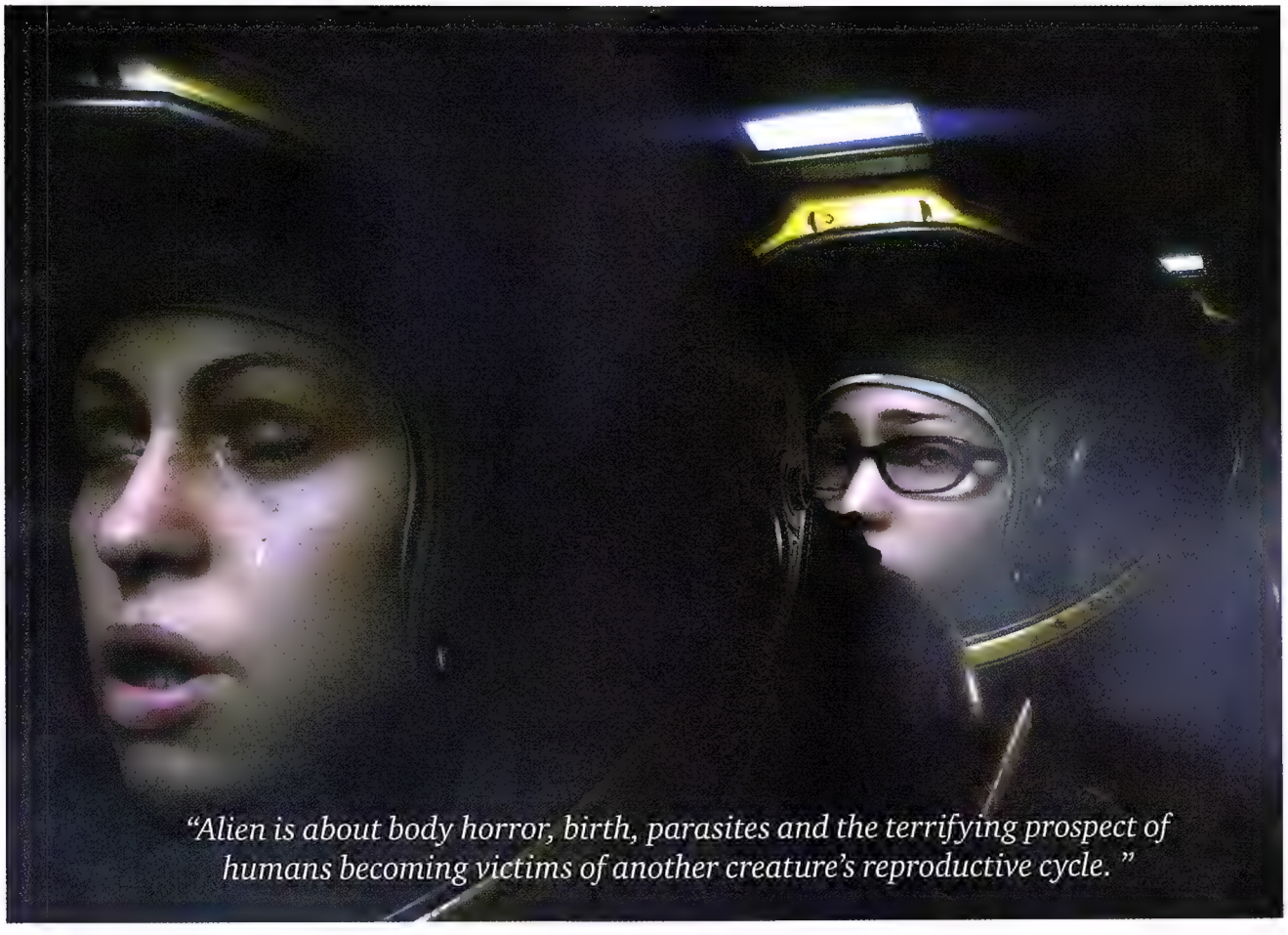
GAME OVER, MAN

Know your enemy

1 JAW JAW
One mouth isn't enough for this predator. Brushing its teeth is complicated.

2 BLOODY MESS
It's difficult to hurt it but don't let the Alien bleed on you, it's acid blood.

3 CLEVER GIRL
The Alien hunts methodically, and is sensitive to every noise you make.



"Alien is about body horror, birth, parasites and the terrifying prospect of humans becoming victims of another creature's reproductive cycle."

system. In an era when autosaving is expected in all games, it's a bold move to build a game around static save points scattered around the level.

It can be irritating to have to navigate the same sector of the ship repeatedly, but the save system forces you to move around and take risks. Brilliantly, it takes a few seconds for your game to actually save when you activate a point. You enter a card and a series of bulbs light up before your game saves. That stops you from just legging it to a save point and instantly moving through an area, and it creates intense moments when you know the creature is searching so close that it could spot you at any moment. It creates moments when you swear at the technology under your breath – c'mon c'mon c'mon, hurry up, stupid machine. It's Ellen Ripley screaming at the ship's AI at the end of *Alien*.

Close encounters

Isolation preserves the Alien's menace for a long time by removing it from the game for particular sections. This relies on its underrated second class of villain – the army of Working Joe androids that have, of course, gone rogue.

The Working Joes present a different challenge to the Alien. Firstly, you can actually fight them, though doing so requires you to spend scarce crafting resources on ammo. They are a lot dumber than the Xenomorph, but they are legion, and they patrol areas in patterns.

The game juggles these two enemies to create a changing sense of pace for the first two thirds of the game. *Alien: Isolation* does run too long, however. Once you've experienced the horror of going into a vent system with the Alien, and met facehuggers, you've seen everything that made the series famous. The plot pushes on, though, and the plight of the Sevastapol and Amanda Ripley's quest aren't quite enough to keep the momentum going until the very end.

Isolation also exposes some of the limitations of games as a medium, which are able to capture *Alien*'s hide-and-seek sections, and even more easily capture the space marine fantasy of the second film. The horror of *Alien* isn't purely in the creature itself, as masterfully designed as it is. *Alien* is about body horror, birth, parasites and the terrifying prospect of humans becoming victims of another creature's reproductive cycle. *Alien: Isolation* comes closer than any other game to recreating the look and feel of the universe, but can't explore the underlying psychology that makes the Alien truly scary. Ultimately, it's just a boogeyman. A smart, beautifully animated boogeyman, but in the end, just another videogame enemy with sharp claws.

It's hard to imagine how *Alien: Isolation* could have done better, though. We have seen some awful *Alien* games, so it's a treat to replay a game that truly gets the universe. It builds on the audiovisual design of the first film, and even enhances it. As we move through generations of ever-improving graphics engines, Isolation shows how much design and art direction matter. I can't imagine anyone making a better *Alien* game than this. ■

MACHINE OF THE MONTH

Commodore 64

John Knight looks back at one of *APC*'s favourite machines.

With a manufacturing lifespan of 12 years, the Commodore 64 is one of the most popular computers in history, with an astonishing library of games, business apps, and multimedia demos. However, this is not simply an old games console. For most software, you can't just press the On button and get started – there are machine quirks to contend with, command prompts to learn, and multiple storage formats to master. So, how do you even get started?

We will show you how to emulate the machine and hit the ground running with the best choice of emulator, how to get your virtual Commodore optimised before gaming, how to load software, and where to find it. Along the way, we'll explore the history of the Commodore 64, with its clever choice of hardware, legendary gaming scene, and expansion into the worldwide market. We'll examine the machine's death and resurrection, following the shift from the booming market of the '80s to the budget gaming scene of the '90s, and explore the boutique industry that keeps the Commodore 64 running today.

Birth

The Commodore 64 (or "C64") was a powerhouse computer that reflected the bullish aggression of the company's CEO, Jack Tramiel. Although somewhat expensive on launch, Tramiel took the machine on an all-out price war that would win its place as the best selling computer of all time.

Named after its 64KB of RAM, the Commodore 64 was designed to be a great games machines from the outset. At its heart was a MOS 6510 CPU – a variant of the trusty MOS Technologies 6502. Despite being technically slower than much of the competition, it was easier to program than Z80 computers, and custom chipsets powered functions separately from the CPU.

Graphically, the powerful VIC-II chip gave the Commodore 16 colours, multicolour hardware sprites, smooth scrolling, and an impressively high resolution for its time. The SID sound chip was developed by an actual musician, Ensoniq's Robert Yannes. Unimpressed with the primitive state of computer audio, Yannes designed a chip that wiped the floor with the competition, and is still used for certain musical applications today – there are even live C64 cover bands!

YOU'LL NEED ICE (THE VERSATILE COMMODORE EMULATOR)
Download from http://vice-emu.sourceforge.net for your Windows or Linux PC.

Commodore's choice of hardware for its budget hit a sweet spot that punched well above its weight. By prioritising gaming, the C64's hardware enabled users to have graphics and sound head and shoulders above the competition, quickly establishing the Commodore as the gaming computer of choice.

Most notable was its use of hardware sprites. That may mean little nowadays, but in modern terms, the difference is a bit like having a dedicated graphics card rather than just onboard video. While other machines may have had more RAM or better BASIC, their screens had ugly tearing, colour clashes, or inferior audio through cheap sound chips.

Commodore 64 MicroComputer
High Resolution & Sound Synthesizer · Alta risoluzione grafica
commodore
Commodore 64 MicroComputer
High Resolution & Sound Synthesizer · Alta risoluzione grafica e sintetizzatore di suono

There have been numerous C64 recreations – is there an original model lurking in your attic or garage?

Taking care of business

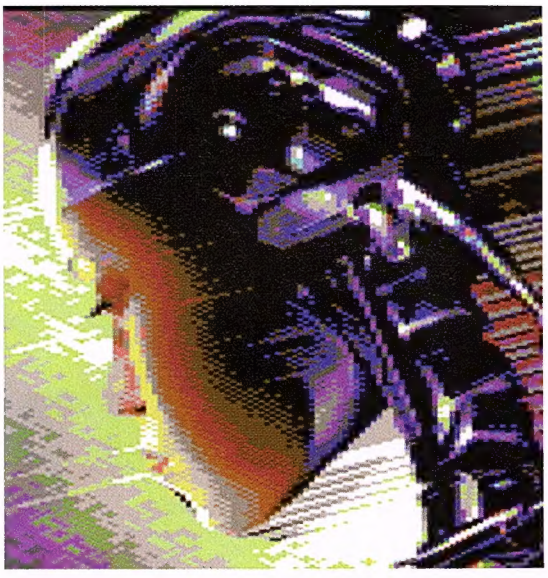
Commodore's market dominance and cheap price also gave it a healthy business market. Why pay thousands for an Apple or IBM PC when you could spend a few hundred on something that just uses a television?

Although American audiences had moved on by the late '80s, the C64 enjoyed a resurgence in the early '90s, where it was sold as a budget games machine, winning more users than Nintendo's Entertainment System in many areas. Despite Commodore's eventual bankruptcy in 1994, Eastern Europeans kept using C64s until the late '90s.

The Commodore's ubiquity has guaranteed its place in the retro scene, where it is one of the most popular collector systems. Not only did it receive a "Mini" remake in 2017, but the last decade in general brought renewed support. Not only was there new hardware, such as upgrade boards and SD card readers, but new commercially available software is still being written by indie publishers, such as 2017's *Planet X2* from YouTube's The 8-Bit Guy.

How to emulate

Our main choice of emulator is VICE. This is the most maintained



Find software

Stretching from 1982 to today, the Commodore 64 library is colossal. Obviously, there are ROM and abandonware sites – and pretty much any site will do – but we can't endorse these for legal reasons. **Archive.org** has plenty of software to choose from (some of which will even run in your browser), and **C64.com** is an invaluable resource with more software than you could ever hope to browse.

The C64 had a strong magazine scene, which came with coverdisks and tapes. These were packed with multimedia demos, game demos, and even full games. Coverdisk and covertape archives are a great source for software, cataloged through the years and documented in magazine issues.

If you fancy buying new software for the system, there are numerous indie labels selling new titles for the C64, including Psytronik Software (**www.psytronik.net**), Protovision (**www.protovision.games**), and Doublesided Games (**http://doublesidedgames.com**). Modern highlights include *Organism* (2015), *Sam's Journey* (2017), and *Farming Simulator–C64 Edition* (2018).

project with very accurate emulation, and many recent improvements have been made to the interface. VICE supports Windows, Linux, MacOS X, and a range of obscure platforms. VICE not only emulates the C64, but also supports other Commodore machines, such as the Pet, 128, and VIC-20.

For the Windows version, head to **http://vice-emu.sourceforge.net** and download the latest build. Most of these files use the 7zip format, so you may need a separate application for that. VICE doesn't come with an installer, so after extracting the package, you'll have to go into the folder and manually open x64.exe – you might want to make a desktop shortcut!

For Linux users, VICE is available in the repositories, but is probably missing key files (chiefly its "kernal" file) because of licensing restrictions. You can get these files from a source tarball, but it's easier to install a Snap or Flatpak package. Both versions should install entries in your system menu. Snap users can find the package on the Snapcraft store (free) under the name vice-jz. If you prefer Flatpak, install VICE with the command:

```
$ flatpak install flathub net.sf.VICE
```

Usage

Before you get started on any games, define how you will use joysticks – whether they be keyboard emulated, or by a proper external device. From the system menu, choose "Input devices > Joystick settings." You really need two ports; most games use joystick port 2, so whatever you intend to use most, set that keyset or joystick to use port 2, and have your backup on port 1. Save your configuration via "Settings > Save settings."

Although cartridges were available, most C64 software came on tape or disk, which will be in T64 or D64 file format. The easiest way to load something is by clicking "File > Smart attach disk/tape." Choose your file and click "Attach." VICE now automates all the usual loading processes, entering the BASIC commands for you. If you get stuck at a BASIC prompt saying "LOADING, READY" with a blinking cursor, try typing "RUN" and pressing Enter.

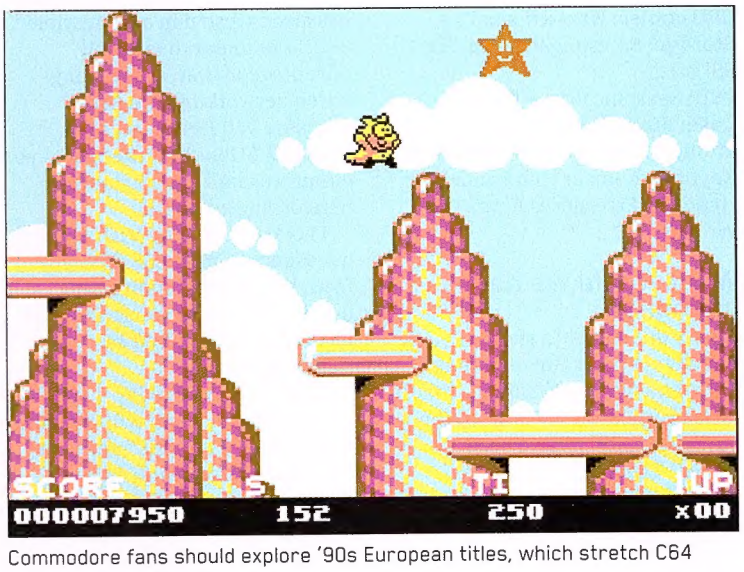
The C64 had a massive public-domain demo scene, where coders would push the machine to its absolute limits.

SPECIFICATIONS

CPU MOS Technology 6510 @ 1MHz
RAM 64KB
Graphics 320x200, 16 colours
Sound SID 6581
Storage Cassette, 5.25-inch floppy, ROM cartridge
OS Commodore Kernal/Basic 2.0
Released August 1982
Production 1982–1994
Worldwide sales 17 million

Alternate option: CCS64

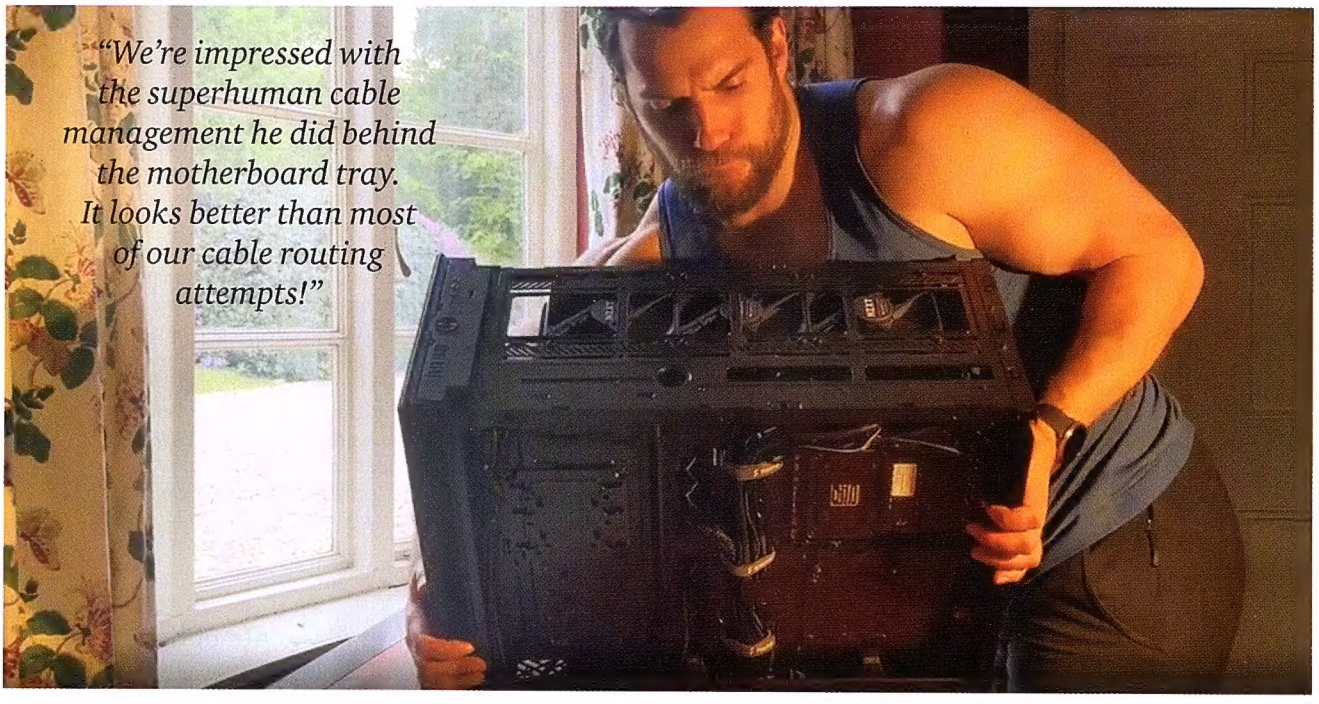
Windows users might consider trying CCS64 (**http://ccs64.com**), which is an older emulator with cool tricks and hacks you won't find elsewhere, such as shortcuts for BASIC. There are newer versions for modern Windows using DirectX 9.0, older versions that work on DOS, and a very old version for Linux (good luck getting it working now). CCS64 isn't the most intuitive of interfaces and is primarily keyboard-driven. F11 and F12 are quick load and quick save, which you'll use a lot. On the plus side, it's very easy to forget you're using a PC, because the interface is highly immersive, feeling almost 8-bit itself. ■



Commodore fans should explore '90s European titles, which stretch C64 gaming to near 16-bit levels.

CHIP CHAT

THE UNUSUAL SIDE OF TECH NEWS


"We're impressed with the superhuman cable management he did behind the motherboard tray. It looks better than most of our cable routing attempts!"

Special Henry Cavill builds a PC edition

Along with his on-screen heroics as both *Superman* and *The Witcher*, impossibly handsome actor Henry Cavill is also considered a hero among gamers the world over, thanks to his unabashed enthusiasm for PC gaming. Now, the Man of Steel has now to Instagram in a video that shows building a new gaming rig from scratch.

Given that Cavill himself is a beast of a man, it's perhaps no surprise that the muscular actor's new gaming-PC build is also something of a monster.

CPU: AMD Ryzen 9 3900X
Motherboard: Asus ROG Crosshair VIII Hero (Wi-Fi)
Memory: G.Skill Trident Z RGB 32GB DDR4-3600 CL16 (2 x 16GB)
Graphics card: Asus GeForce RTX 2080 Ti 11 GB ROG Strix Gaming OC
CPU cooler: Nzxt Kraken Z73
Storage: Samsung 970 Pro 1TB SSDs x 2
PSU: Seasonic Prime TX-1000
Case: Fractal Design Define 7 case
Monitor: Asus PG279Q ROG Swift
Keyboard: Razer Huntsman Elite
Headset: Steelseries Arctis Pro Wireless

What would we have changed?

This is undeniably a stellar, punchy rig that's full of premium parts and with performance that'll kick any modern PC game to the curb. But could it have been better? The *APC* team put their collective heads together to assess Mr Cavill's build and the components he selected – and hats off to Henry for doing us all proud!

The 3900X CPU is solid for games and productivity. If he only games, why did he get sucked into the AMD hype train? Combined with the X570, he has an upgrade path to the much awaited Zen3 CPU coming in a few months and possibly even the final AM4 architecture, Zen4.

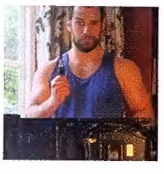
The motherboard features a built-in 802.11ax Wi-Fi 6 adaptor with a theoretical maximum of 2402Mbps on the 5GHz band, and 574 on 2.4GHz. So we hope Henry has also invested in a compatible 802.11ax router to take full advantage of that. If he's using wired networking, the Asus Crossfire VIII Hero features a speedy 2.5Gbps Ethernet port – so either way he's got outstanding networking potential.

The Asus Crossfire VIII Hero has a reasonably good ESS ES9023P DAC, but for maximum audio fidelity we'd suggest installing an EVGA Nu Audio sound card, or the Sound Blaster AE-9.

Two Samsung 970 Pro 1TB SSDs are nice and fast and will give him lots of capacity for his games. Pro SSDs are a little overkill for gamers – especially with Evo's being cheaper. But this is Superman, he needs the best.

Choosing 3600MHz memory is wise – that's the Ryzen's sweet spot, but the C16 timing is a bit of a let down. We recommend Henry consider a kit with latency as low as C14 or even less for a truly super system.

Henry unhelpfully obscured the brand names, but our trained eyes and a lot of video pausing easily identified the components.



Henry's choice of monitor is a no-compromise best-of-the-best Asus ROG PG27UQ, which packs in every conceivable tech, including G-Sync (nicely matching his Nvidia 2080Ti), 144Hz refresh, quantum dots for superior colours as well as HDR – and all running at a tasty 4k resolution, which the 2080Ti should be able to power adequately.

We're impressed with the superhuman cable management he did behind the motherboard tray. It looks better than most of our cable routing attempts! Dude knows how to cable.

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